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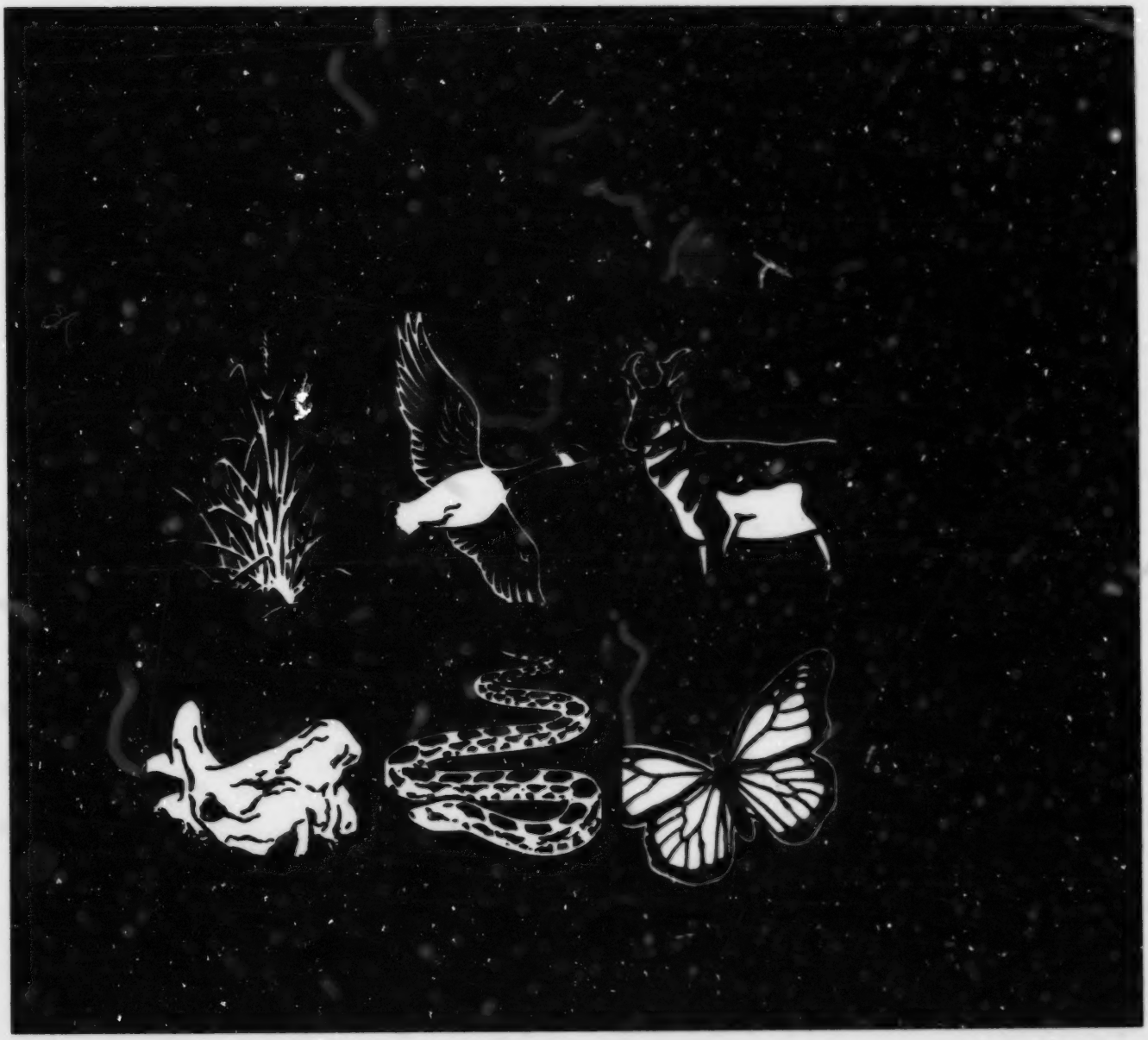
Natural History Contributions | Number 2

Mammals of the Riddell Local Fauna
(Floral Formation, Pleistocene, Late Rancholabrean) Saskatoon, Canada



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Natural History Contributions No. 2

Mammals of the Riddell Local Fauna (Floral Formation, Pleistocene, Late Rancholabrean) Saskatoon, Canada

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Mammals of the Riddell Local Fauna (Floral Formation, Pleistocene, Late Rancholabrean) Saskatoon, Canada

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The Riddell local fauna, recovered from fluvial sand, which occurs between tills of the Floral Formation in the Saskatoon area, is composed of nineteen taxa of mammals. It contains the most northern record of *Cynomys* cf. *C. ludovicianus* and extends the reported Pleistocene distribution of *Equus conversidens* farther north and east on the Canadian prairies. The presence of *Lagurus curtatus* and the evolutionary grade of *Ondatra zibethicus* confirm a late Rancholabrean age for the Riddell local fauna.

The habitat preferences of the known extant species present in the Riddell local fauna suggest that the climate at the time of deposition was probably much like it is today. The landscape is believed to have been dominated by open grassland with trees and shrubs in low areas.

(Mammalia: Pleistocene: Saskatchewan)

INTRODUCTION

Geological Setting

North of the City of Saskatoon, along the South Saskatchewan River, the rolling terrain is composed of low, boulder-capped hills. In places the boulders protect stratified fluvial sands and gravels of the Floral Formation. Exposures are common in road cuts and commercial excavations, and fragments of fossil bone, shells, and wood are readily visible.

One exposure, Riddell Site, has long been known to contain vertebrate fossils. Superficial collecting by various field parties over the years indicated that extensive, concentrated collecting was feasible and that a large quantity of good quality fossils could be expected.

The Riddell Site is a sand pit, located in the southwest quarter of l.s.d. 5, Sec. 13, T. 37, R. 5, W. 3 M. (Fig. 1). It is situated on the east side of the South Saskatchewan River, about 0.75 km north of the city limits. The entrance to the site is a cut into the north slope of a low hill where it drops abruptly into a ravine. Excavation by commercial interests has created a large, U-shaped pit. The

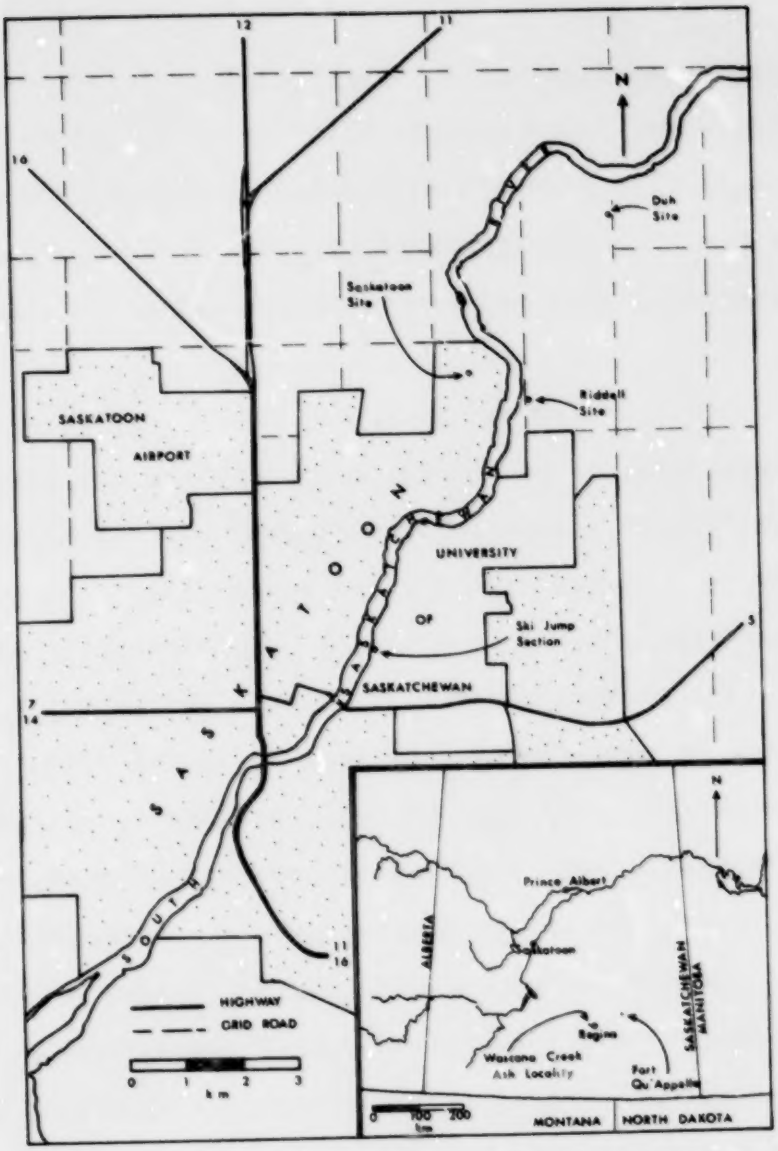

Fig. 1. Map of vertebrate fossil localities in the Saskatoon area and (inset) localities in south-central Saskatchewan mentioned in the text.

exposed sand varies in thickness from less than 1 m on the northeast side to 6 to 7 m on the south side. Continued excavation toward the south into the crest of the hill has increased both the surface area of accessible sand and the vertical exposure of the section.

The exposed section consists of up to 7 m of stratified, cross-bedded, and poorly sorted sand overlain by a faceted and striated boulder pavement. Many of the boulders are contained within the sand. Approximately 1 m of surficial drift overlies the boulder pavement. The base of the sand is not exposed in the section, but test-holes indicate that the sand is underlain by till. Radiocarbon dating of an equid metapodial recovered from this deposit and submitted to the Saskatchewan Research Council, Radiocarbon Dating Laboratory, has yielded a date of 15 340±500 years B.P. (S-1305). Bison post-cranial fragments recovered from the overlying sediment have yielded an age of 4560±115 years B.P. (S-1306) (Rutherford, *et al.*, 1979, p. 54).

The radiometric date of 15 340±500 years B.P. is considered invalid. Christiansen (1979) has

shown that final deglaciation in Saskatchewan began about 17 000 years B.P. and that the Saskatoon area was glaciated until about 12 000 years B.P. This is inconsistent with the presence of a diverse fauna in the area 15 340±500 years B.P. and indicates that the fauna must date from earlier in the Pleistocene.

The sand is fine to medium grained; in some places it is coarser but in others it is very fine and contains much silt and clay. In many places individual beds (average thickness 5 cm) can be seen in which the particles are predominantly coarse, poorly sorted, and mixed with shells and silt at the base, and grading upward into fine, uniform sand and silt in which shells are less common. There is a tendency for these beds to be repeated, mainly in cross-bedded units of 0.3 to 1 m thickness. The sand is cut by many local disconformities. A predominant post-depositional feature is the pronounced local deformation of cross-bedded units. This deformation appears to be similar to that described by Hendry and Stauffer (1975) from similar sand deposits in the Saskatoon Site (Fig. 1).

Two other exposures of fossiliferous sand

in the Saskatoon area have been reported previously. The Saskatoon Site has yielded a variety of large mammal specimens which suggest that the environment at the time of deposition was temperate. Various aspects of the deposit have been described by Christiansen (1968), Lammers (1968), and Hendry and Stauffer (1975). Only fragmentary specimens of bone were collected by the author at the Saskatoon Site. Fossils from the Duh Site, previously known as the Sutherland Pit, were reported by Russell (1943). He described horse teeth and indicated that mammoth and bison bones were also recovered. The exact provenance of these specimens cannot be determined, but collecting by the author suggested that many of Russell's specimens must have been recovered from coarse gravels exposed at the site. Only about 0.15 m of fluvial sand beneath the gravel is present at the Duh Site.

Systematic collecting of fossils at Riddell Site indicated that, although fossil shells occur predominantly along bedding planes, bones are randomly distributed throughout the deposit. However, some bones lay at the interface of two beds, usually

resting on very fine-grained, silty sand but enclosed in a much coarser matrix. The fossil bones recovered from Riddell Site are incomplete. There is no evidence that they were subjected to subaerial weathering. The only complete specimens recovered are small bones and teeth of both large and small mammals. No articulated fossil specimens were found. Abrasion due to water transport is common but more pronounced on some specimens than on others. Some post-depositional breakage, presumably due to local deformation of the sands, was also noted. Fossil wood is common at Riddell Site but is very poorly preserved.

Filled burrows are a common feature of the sand deposit. Burrows in the sand exist today and are made primarily by ground squirrels, *Spermophilus richardsonii*. That ground squirrels were responsible for digging the now filled burrows is evident from their skeletal remains in the burrows. The filled burrows are readily detected because the type of fill, although varying from burrow to burrow, differs everywhere in composition from the enclosing sand, and because the fill is more resistant to wind and water erosion than the surrounding matrix. The

burrow casts thus appear in positive relief on the face of the exposure. Because the burrows cut across primary sedimentary features they are a post-depositional feature. The time of their excavation cannot be determined more exactly.

Most of the skeletons of *Spermophilus richardsonii* recovered from burrows are complete and articulated. They display a range in degree of staining from very greasy and "fresh-looking" to relatively heavily limonitic. This suggests that burrowing persisted over a considerable but indeterminable length of time.

The lithology at Riddell Site is illustrated in Figure 2. A faunal list is provided in Table 1.

Laboratory Procedures

All specimens collected at Riddell Site were catalogued in the collection of Vertebrata: Mammalia (VM) of the University of Saskatchewan Geology Museum (GMUS: VM1 - VM430). All measurements of the teeth of rodents and lagomorphs were made using a Leitz microscope equipped with a zoom lens and a *camera lucida* attachment. The microscope was focused on a caliper and the magnification

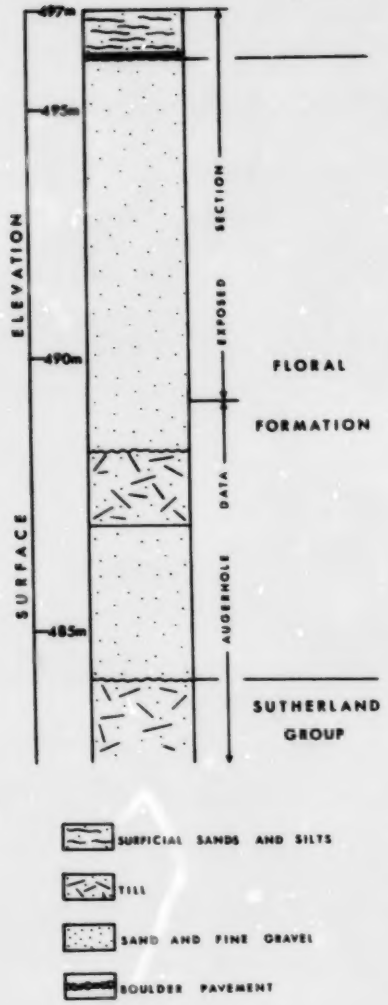

Fig. 2. Lithology of Riddell Site. The upper sand unit, 7 m of which is exposed, comprises the provenance of the Riddell local fauna. The surface elevation is given as height above mean sea level (AMSL) in metres. Subsurface data are from Christiansen (1973, p. 11).

Table 1. Faunal list of recovered vertebrate fossils from Riddell Site.

Class Pisces

1. gen. and sp. indet.

Class Mammalia

Order Lagomorpha

Family Leporidae

2. *Lepus* cf. *L. americanus*

3. *Lepus* sp.

Order Rodentia

Family Sciuridae

4. *Spermophilus (Spermophilus) richardsonii*

5. *Spermophilus* cf. *S. (Spermophilus) undulatus*

6. *Cynomys* cf. *C. (Cynomys) ludovicianus*

Family Geomyidae

7. *Thomomys talpoides*

Family Cricetidae

Subfamily Arvicolinae

8. *Clethrionomys gapperi*

9. *Phenacomys intermedius*

10. *Microtus* cf. *M. (Microtus) pennsylvanicus*

11. *Microtus* sp.

12. *Lagurus curtatus*

13. *Ondatra zibethicus*

Order Carnivora

Family Canidae

14. *Canis* cf. *C. latrans*

15. *Vulpes* cf. *V. vulpes*

Order Proboscidea

16 Proboscidea gen. and sp. indet.

Order Perissodactyla

Family Equidae

17. *Equus conversidens*

Order Artiodactyla

Family Camelidae

18. *Camelops* cf. *C. hesternus*

Family Cervidae

19. Cervidae indet., ?*Odocoileus*

Family Antilocapridae

20. *Antilocapra* cf. *A. americana*

adjusted so that 1 mm was projected via the *camera lucida* onto 10 mm of drafting grid calibrated in millimetres. The specimens were thus measured accurately to 0.05 mm. Mesiodistal and buccolingual diameters of the cheek-teeth are given as the greatest lengths (anteroposterior) and widths (buccolingual) at the occlusal surface measured parallel to and perpendicular to the tooth row or tangent to its arc. Measurements of the larger specimens were taken using either a NSK micrometer with a range of 0 - 25 mm and accurate to 0.01 mm or INOX vernier calipers with a range of 0 - 140 mm and accurate to 0.05 mm.

The terms mesial and distal are preferred over anterior and posterior when describing mammal teeth, except when the latter terms form part of the name of a specific dental structure (*e.g.* anterior and posterior loops of arvicoline molars). Similarly, the terms buccal and lingual are preferred over the corresponding terms external and internal.

The following abbreviations are used in the text: I = incisor; C = canine; dp = deciduous premolar; dm = deciduous molar; P = premolar;

M = molar; L = left; R = right. Therefore, the designation $RM^{\overline{3}}$ represents right molar, upper third. Also, in tables of measurements N = number of specimens per sample; $\overline{X}$ = arithmetic mean for sample; Min.-Max. = observed range, smallest (minimum) to largest (maximum) of sample.

All illustrations are accompanied by a scale bar in millimetres. Most illustrations on any one figure are drawn to the same scale, but where scales vary on one figure separate scale bars are provided for each illustration on each figure.

The orientation of drawings is explained in the captions that accompany figures. However, the occlusal surfaces of cheek-teeth are oriented consistently as follows. The teeth are arranged into quadrants of the oral cavity with their mesial edges oriented toward the vertical axis and their lingual margins toward the horizontal axis. Therefore, the orientation is such as if the animal were facing the reader. Each illustration of isolated teeth is accompanied by cross-hairs to indicate orientation. This orientation technique is illustrated in Figure 3.

The Pleistocene succession based on evidence from

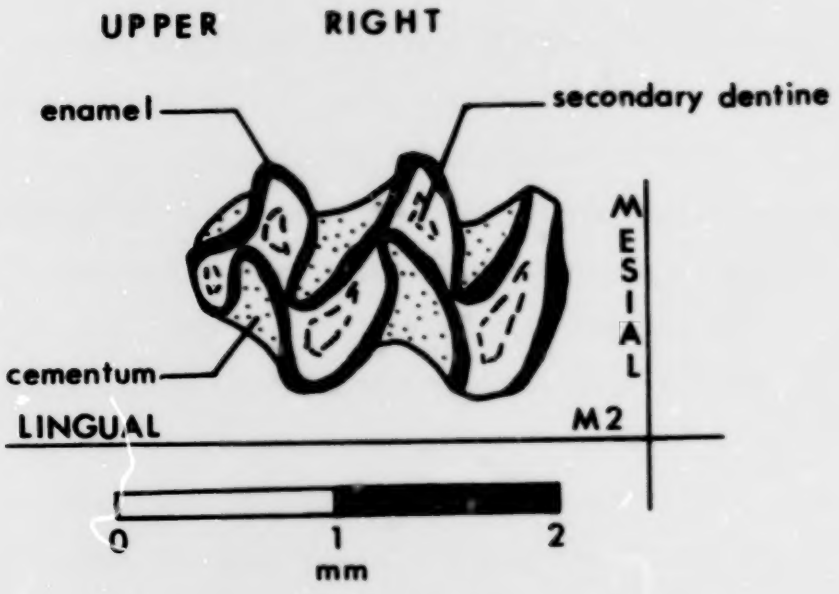

Fig. 3. A tooth, RM^2 (right, upper second molar) of *Microtus pennsylvanicus* (U. of S. Biology 1733) is shown to depict the technique used to orient teeth in illustrations. Cross-hairs indicate to which quadrant of the mouth the illustrated tooth belongs (the vertical axis represents the mesial edge, the horizontal axis the lingual surface). Letter and number indicate position in the tooth row. Enamel is represented by solid black, cementum is stippled, and the area of secondary dentine is indicated within a light dashed line.

absolute dating is shown in Figure 4. It illustrates attempts to correlate Pleistocene stratigraphy with polarity reversals and volcanic ash horizons, and with intercontinental mammalian faunal interchanges. The dispersal of arvicoline rodents across North America and Europe is now being used for both local and international correlation.

The following is a list of abbreviations of specific museum collections used in the tables of measurements:

CUM	University of Colorado Museum (Boulder).
I.S.C.	Idaho State College (Pocatello), now the Idaho State University Museum.
KU	University of Kansas (Lawrence).
LACM	Los Angeles County Museum (Los Angeles).
MU	Midwestern University (Witchita Falls).
NMC	National Museums of Canada (Ottawa).
PMA	Provincial Museum of Alberta (Edmonton).
ROM	Royal Ontario Museum (Toronto).
SDSM	South Dakota School of Mines (Rapid City).
SMM	Sternberg Memorial Museum, Kansas (Hays).
SMNH	Saskatchewan Museum of Natural History (Regina).

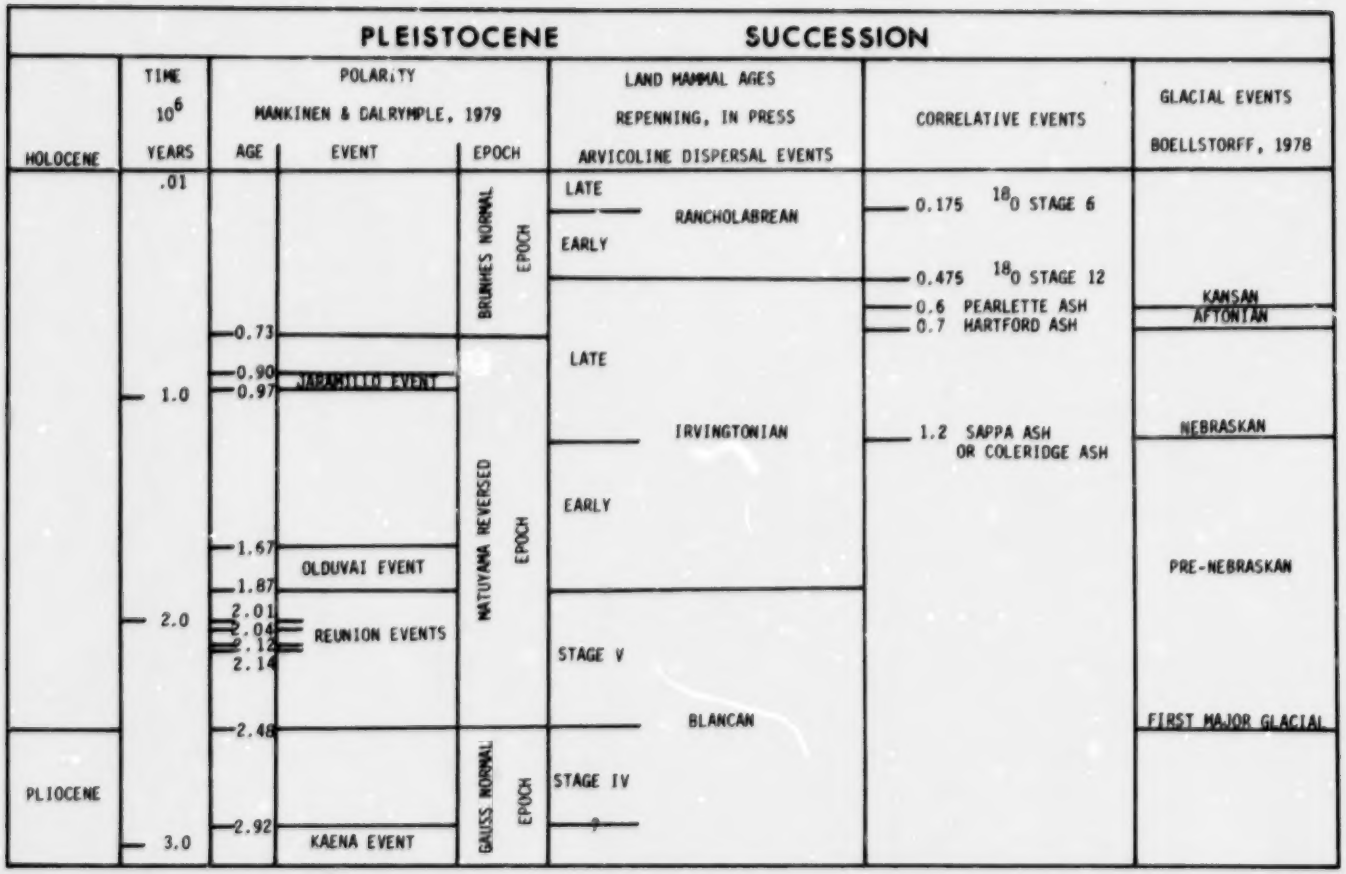

Fig. 4. Provincial land mammal ages and glacial stratigraphic division of Pleistocene deposits in North America based on correlation of absolute dating (Boellstorff, 1978; Mankinen and Dalrymple, 1979) with mammalian migrations and extinctions (Repenning, 1978; in press, Fig. 1).

SMU Southern Methodist University (Dallas).

UA University of Alberta (Edmonton).

UCMP University of California Museum of Paleontology (Berkeley).

UMMP University of Michigan Museum of Paleontology (Ann Arbor).

USNM United States National Museum (Washington, D.C.).

SYSTEMATIC VERTEBRATE PALAEONTOLOGY

ORDER LAGOMORPHA

FAMILY LEPORIDAE

Lepus cf. *L. americanus* Erxleben, 1777

Fig. 5, 6

Geological Range

Rancholabrean - Recent (?Yarmouth - Holocene).

Material

Upper left cheek-tooth, $P\frac{3}{-}$ or $P\frac{4}{-}$ or $M\frac{1}{-}$ or $M\frac{2}{-}$ (VM63); partial upper left cheek-tooth (VM64); upper right cheek-tooth, $P\frac{3}{-}$ or $P\frac{4}{-}$ or $M\frac{1}{-}$ or $M\frac{2}{-}$ (VM65); partial upper right cheek-tooth (VM66); fragments of upper cheek-teeth (VM67, VM68, VM69); $LP\frac{}{3}$ (VM59); partial $LP\frac{}{3}$ (VM60); partial $LP\frac{}{3}$ or $RP\frac{}{3}$ (VM61);

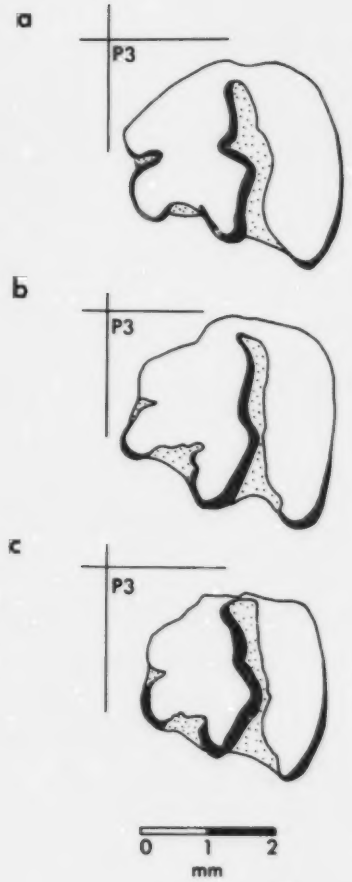

Fig. 5. Comparison of $LP_{\overline{3}}$ of *Lepus* cf. *L. americanus* from Riddell Site (a, VM59), and of extant *Lepus townsendii* (b, U. of S. Biology 1867) and *Lepus americanus* (c, U. of S. Biology 1162).

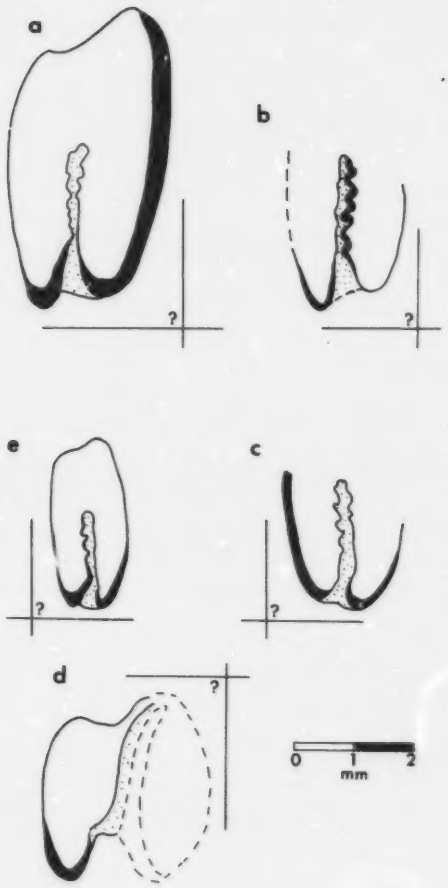

Fig. 6. Cheek-teeth of *Lepus* cf. *L. americanus* (a-d) and *Lepus* sp. (e) from Riddell Site (a, VM65, $RP\frac{3}{-}$ or $RP\frac{4}{-}$ or $RM\frac{1}{-}$ or $RM\frac{2}{-}$; b, VM66, partial $RP\frac{3}{-}$ or $RP\frac{4}{-}$ or $RM\frac{1}{-}$ or $RM\frac{2}{-}$; c, VM64, partial $LP\frac{3}{-}$ or $LP\frac{4}{-}$ or $LM\frac{1}{-}$ or $LM\frac{2}{-}$; d, VM62, partial $RP\frac{-}{4}$ or $RM\frac{-}{1}$ or $RM\frac{-}{2}$; e, VM63, $LP\frac{3}{-}$ or $LP\frac{4}{-}$ or $LM\frac{1}{-}$ or $LM\frac{2}{-}$).

partial right lower cheek-tooth, $P_{\overline{4}}$ or $M_{\overline{1}}$ or $M_{\overline{2}}$ (VM62).

Discussion

The seven isolated specimens (and fragments) recovered display a wide range in size. The cheek-teeth were compared with specimens of recent *Lepus americanus* and *L. townsendii*. The size range of *L. americanus* overlaps that of the larger species, *L. townsendii* (Table 2, 3). The lower third premolars are large and, as the measurements given in Table 2 indicate, could fit well within the range of either *Lepus americanus* or *L. townsendii*.

$P_{\overline{3}}$ and $P^{\overline{2}}$ are considered taxonomically diagnostic in rabbits (see Dawson, 1958, p. 7; Hibbard, 1963, 1969; Storer, 1976). On this basis the specimens recovered indicate that *Lepus* is the genus represented. This assignment is confirmed by the simple crenulations of the hypostria of the upper cheek-teeth.

The main criteria that can be used to try to distinguish *Lepus americanus* from *L. townsendii* are size and extant geographical range. On the basis of size alone the recovered specimens could be regarded as small *L. townsendii* or large *L. americanus*.

Table 2. Measurements (mm) of $P_{\overline{3}}$ of *Lepus* cf. *L. americanus* from Riddell Site compared with measurements of $P_{\overline{3}}$ of extant *Lepus americanus* and *L. townsendii*.

	Lepus cf. *L. americanus*	*Lepus townsendii*			*Lepus americanus*		
Dimension	VM59	N	$\overline{X}$	Min.-Max.	N	$\overline{X}$	Min.-Max.
Maximum mesiodistal diameter	3.25	13	3.60	3.15-3.90	13	2.80	2.40-3.15
Maximum buccolingual diameter across trigonid	2.75	13	3.25	2.95-3.55	13	2.45	1.95-2.85
Maximum buccolingual diameter across talonid	3.15	13	3.45	3.15-3.85	13	2.80	2.20-3.30

Table 3. Measurements (mm) of upper molariform cheek-teeth of *Lepus* cf. *L. americanus* and *Lepus* sp. from Riddell Site compared with measurements of upper molariform cheek-teeth of extant *Lepus americanus* and *L. townsendii*, and with Leporidae gen. and sp. indet. from Hand Hills, Alberta (Storer, 1976, Table 7).

Dimension	*Lepus* sp. VM63	*Lepus* cf. *L. americanus* VM65	VM66	Leporidae gen. and sp. indet. (UA8537)	(UA8538)	(UA8539)
Maximum mesiodistal diameter	1.3	2.6	2e	2.3	2.7	2.3
Maximum buccolingual diameter	2.7	4.7		3.6	4.4	4.0

Dimension	*Lepus americanus* U. of S. Biology 1162 $LP^{\underline{3}}$	$LP^{\underline{4}}$	$LM^{\underline{1}}$	$LM^{\underline{2}}$	*Lepus townsendii* U. of S. Biology 1876 $LP^{\underline{3}}$	$LP^{\underline{4}}$	$LM^{\underline{1}}$	$LM^{\underline{2}}$
Maximum mesiodistal diameter	2.1	2.2	2.3	1.9	2.4	2.3	2.2	2.2
Maximum buccolingual diameter	4.2	4.2	4.0	3.6	5.1	5.0	5.0	4.8

The species *Lepus americanus* is widespread in Canada, avoiding only the extreme Arctic, whereas *L. townsendii* has a much restricted range in Canada occurring only in the semi-arid regions of southwestern Saskatchewan and southeastern Alberta (Hall and Kelson, 1959, p. 274, 281; Banfield, 1974, p. 84). However, *L. townsendii* seems to be expanding its range northward with the advance of agriculture (Banfield, 1974, p. 90).

The combination of the two factors, size and distribution, suggests a tentative assignment of the recovered specimens to *Lepus americanus*. The size of some specimens suggests large individuals of *L. americanus*. The restricted prehistoric distribution of *L. townsendii* and the widely adapted nature of *L. americanus* suggest that the fossil material derives from *Lepus americanus*.

Genus *Lepus* is an Asian immigrant into North America whose arrival has been dated at 2.5 million years B.P. (Downey, 1962; Repenning; 1978, p. 49). Tentative assignment of most Pleistocene specimens is usually made to cf. *L. californicus* or cf. *L. townsendii*. *Lepus* cf. *townsendii* has also been

reported from Canadian fossil localities near Medicine Hat, Alberta which are regarded as of Sangamon age and younger (Russell and Churcher, 1972, p. 18). The Pleistocene distribution of *Lepus americanus* on the Great Plains is poorly documented as that species cannot readily be distinguished on the basis of either size or morphology from *L. townsendii*.

Palaeoecological Implications

The snowshoe hare, *Lepus americanus*, inhabits forests, swamps, and riverbank thickets including the aspen bluffs of the prairies (Banfield, 1974, p. 83). In contrast, the white-tailed jack rabbit, *L. townsendii*, prefers pastures and cultivated fields bordered by willow thickets, and plains covered with native short-grasses and sagebrush. The difficulty of distinguishing between *Lepus americanus* and *L. townsendii* based on teeth alone makes it impossible to determine the geographical distribution and ecological relationships of the two species.

Lepus sp.

Fig. 6

Geological Range

Blancan - Recent (Late Pliocene-Holocene).

Material

Upper left cheek-tooth $P\frac{3}{-}$ or $P\frac{4}{-}$ or $M\frac{1}{-}$ or $M\frac{2}{-}$ (VM63).

Discussion

The single tooth assigned to *Lepus* sp. is very small; considerably smaller than any specimen of recent *Lepus* spp. with which it was compared. Table 3 shows that there is a distinct difference in size when VM63 is compared to the other recovered leporid specimens.

The recovered specimen is assigned to genus *Lepus* and not to *Sylvilagus* because the hypostria is simple, only moderately crenulated, and buccolingually relatively short as in genus *Lepus*.

ORDER RODENTIA

FAMILY SCIURIDAE

Spermophilus (Spermophilus) richardsonii

(Sabine), 1822

Fig. 7

Geological Range

Latest Irvingtonian - Recent (Kansan - Holocene).

Material

$LP\frac{4}{-}$ (VM70); $LM\frac{1}{-}$ or $LM\frac{2}{-}$ (VM71); incomplete $RM\frac{2}{-}$

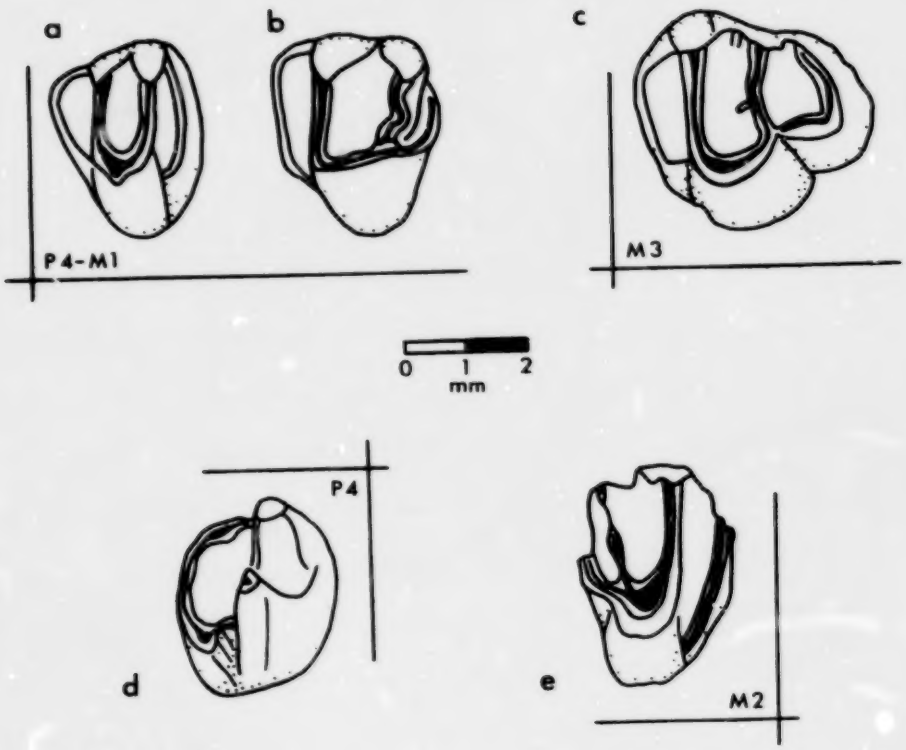

Fig. 7. Cheek-teeth of *Spermophilus richardsonii* (a. VM70, $LP\frac{4}{}$; b, VM71, $LM\frac{1}{}$; c. VM74, $LM\frac{3}{}$; d, VM77, $RP\frac{}{4}$; e, VM73, unrestored $RM\frac{2}{}$).

(VM73), partial $RM^{\underline{1}}$ or $RM^{\underline{2}}$ (VM72); $LM^{\underline{3}}$ (VM74), partial $LM^{\underline{3}}$ (VM82); partial $RM^{\underline{3}}$ (VM75, VM78); $RP_{\overline{4}}$ (VM77), partial $RP_{\overline{4}}$ (VM79, VM429); partial $LM_{\overline{1}}$ or $LM_{\overline{2}}$ (VM80); partial $RM_{\overline{2}}$ (VM81).

Discussion

The recovered specimens are high crowned; the shape of the upper molars is triangular in occlusal outline, the lower molars are parallelogram shaped. They were compared with specimens of recent *Spermophilus richardsonii*, and were found to be morphologically indistinguishable.

Spermophilus richardsonii is first reported from the Cudahy fauna of Kansas and Texas. Paulson (1961, p. 134 - 135) described material which he regarded as similar to or inseparable from elements of recent *S. richardsonii*. The Cudahy fauna is overlain by Pearlette ash, Type 0 which has been dated at 600 000 years B.P. This date suggests a later Irvingtonian (Kansan) age for the species. *S. richardsonii* has been reported from late Rancholabrean faunas (Sangamon and Wisconsin age) found near Medicine Hat, Alberta (Russell and Churcher, 1972, p. 18 - 19). It has also been reported from Pleistocene deposits of the

Hand Hills in Alberta. However, Storer (1976, p. 207) was unable to specify an age for the fauna beyond saying it was Irvingtonian or younger.

Palaeoecological Implications

Spermophilus richardsonii inhabits open prairie but prefers high, rolling hills of gravelly or sandy soils; it quickly moves into cultivated fields and away from wet lands (Schultz, 1965, p. 248; Banfield, 1974, p. 115). It was not common on the prairies until advent of settlement and agriculture. It is part of the extant fauna of the Saskatoon area.

The present geographical distribution of *Spermophilus richardsonii* is relatively restricted in Canada to the prairies between the Precambrian Shield and the Rocky Mountain Foothills, extending south from Manitoba into South Dakota and Minnesota and a western segment extending into Utah and Colorado (Hall and Kelson, 1959, p. 339). However, this ground squirrel appears to be colonizing the Peace River region and has been observed near Grande Prairie, Alberta (Churcher, personal communication, 1978). During the Pleistocene this species was much more widely distributed; extending, for example, from as far south

as Nebraska and Kansas and to as far north as Medicine Hat, Alberta (Green, 1963, p. 690; Hibbard, 1970; Russell and Churcher, 1972, p. 18). The severe post-glacial constriction of range indicates that, for this species, present range is not necessarily a reliable guide to past distribution and habitat preference.

Spermophilus cf. *S. (Spermophilus) undulatus* (Richardson), 1825

Fig. 8

Geological Range

Pleistocene - Holocene.

Material

LM^{1} or LM^{2} (VM202); partial RM^{1} or RM^{2} (VM201).

Discussion

The two teeth assigned to *Spermophilus* cf. *S. (Spermophilus) undulatus* are large and buccolingually wider than mesiodistally long. Each tooth is high crowned and bears a straight, buccolingually oriented protoloph. The metaconule is almost as large as the metacone; the parastyle is prominent. The strong anterior cingulum terminates at a large cuspule

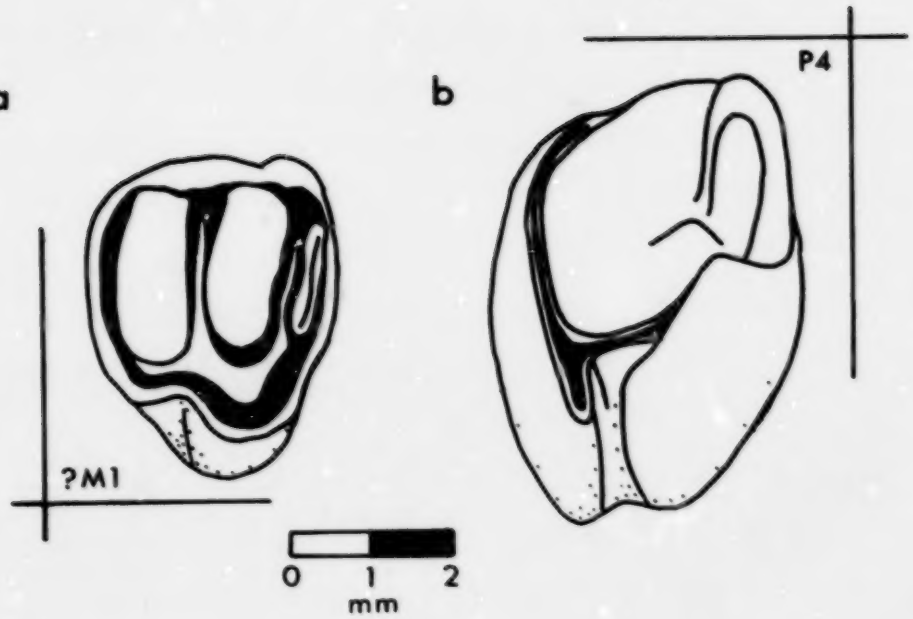

Fig. 8. Cheek-teeth of *Spermophilus* cf. *S. undulatus* (a, VM202, $LM\frac{1}{}$ or $LM\frac{2}{}$) and *Cynomys* cf. *C. ludovicianus* (b, VM54, $RP\frac{}{4}$).

located mesial to the protocone. A large anterior valley and a small mesostyle are present.

The two teeth recovered at Riddell Site have been compared with specimens of extant *Spermophilus richardsonii* and with specimens referred to *S. richardsonii* from Riddell Site. A comparison of the morphological features indicates that both specimens can be referred to the subgenus *Spermophilus*. As these two recovered specimens are considerably larger than any of the comparative specimens, they are assigned to a different taxon (see Table 4). Because *Spermophilus (S.) undulatus* is closely related to *S. richardsonii*, and because the dental morphologies are very similar, the two teeth may derive from this taxon. Also, the size of the recovered teeth compares well with teeth of specimens of *S. parryi (= S. undulatus)* as shown in Table 4.

Spermophilus (Poliocitellus) franklinii is the largest ground squirrel currently extant in the Saskatoon area and both fossil teeth were compared with teeth of *S. franklinii*. However, the fossil teeth are larger and are higher crowned than in modern *S. franklinii* and thus probably not referable to it.

Table 4. Measurements (mm) of $M^{\underline{1}}$ (or $M^{\underline{2}}$) of *Spermophilus* cf. *S. undulatus* from Riddell Site compared with measurements of $M^{\underline{1}}$ of Recent *S. richardsonii*, *S. franklinii*, and *S. parryi (= S. undulatus)*; and of *S.* cf. *richardsonii* from Hand Hills, Alberta (Storer, 1976, Table 6, UA8530).

Dimension	*Spermophilus* cf. *S. undulatus*, VM202	*S. richardsonii* (U. of S. Biology 105)	*S. franklinii* (U. of S. Biology 604)	*S. parryi* (U. of S. Biology 1047)	*S.* cf. *richardsonii* (Storer, 1976, UA8530)	*S. richardsonii* (Storer, 1976, PMAZ70.36.3, Recent specimen)
Maximum mesiodistal diameter	2.64	2.15	2.3e	2.7e	2.1	2.0
Maximum buccolingual diameter	3.65	2.70	2.75	3.75	3.0	3.0

The teeth are questionably referred to *Spermophilus undulatus* on the basis of comparable size and morphological characteristics, such as the development of high crowned molars, which indicate affinity with the subgenus *Spermophilus*. However, the range of variation of modern *S. richardsonii* from all over its latitudinal range has not yet been documented. Large variants may well approach the size of modern *S. undulatus*.

Fossil *Spermophilus undulatus* has been found only from early and late Pleistocene localities in the Arctic (Guthrie, 1968, p. 233; Guthrie and Matthews, 1972, p. 492).

Palaeoecological Implications

The presence of a large spermophile, one unlikely to be *Spermophilus franklinii*, implies the presence in the Riddell local fauna of a taxon no longer extant in the area. The questionable assignment to *Spermophilus undulatus* suggests that an animal currently adapted to the Arctic may once have lived much farther south than its present range. The extent to which post-glacial climatic and faunal zonation affected *S. undulatus* is not known although

one cannot neglect the possibility that its range has become restricted in much the same way that the range of *S. richardsonii* has become restricted.

Cynomys cf. *C. (Cynomys) ludovicianus* (Ord), 1815

Fig. 8

Geological Range

Late Irvingtonian - Recent (Kansan - Holocene).

Material

Partial $LP^{\overline{3}}$ (VM347); $RP_{\overline{4}}$ (VM54); partial $LM_{\overline{1}}$ or $LM_{\overline{2}}$ (VM55, VM56); partial $RM_{\overline{1}}$ or $RM_{\overline{2}}$ (VM57, VM58).

Discussion

The $P_{\overline{4}}$, the only complete specimen available, is unworn which suggests that it derives from a young adult. It is laterally expanded relative to its mesiodistal length; it is mesiodistally narrower on the buccal than on the lingual edge because the talonid is more rounded distolingually. The protolophid dips to the base of the crown midway on the lingual surface, leaving the talonid basin incompletely enclosed. There is no evidence of an entoconid or mesostylid.

The fossil specimens have been compared with

specimens of recent *Cynomys ludovicianus*, the black-tailed prairie dog. Although the recent specimens examined are heavily worn, the fossil specimens are indistinguishable from them. Comparative measurements are provided in Table 5.

Characteristics of the upper molars, especially of the $M\frac{3}{}$; the relationship of the zygomatic arch to the maxilla-premaxilla; and the presence or absence of an undivided mesiodistal valley separating the ectolophid from the talonid basin of $M_{\overline{3}}$ are some of the diagnostic features used in making a specific assignment (Hay, 1921, p. 615; Semken, 1966, p. 141-142; Hager, 1975, p. 23). The present assignment is questionable because none of the diagnostic features is represented. The recovered material indicates that a large sciurid, the size of *Cynomys*, is represented in the fauna. The size and available morphological features, such as laterally expanded cheek-teeth, compare favourably with *Cynomys (Cynomys) ludovicianus*.

The earliest report of *Cynomys ludovicianus* is of assigned Kansan age from Holloman, Tillman County, Oklahoma (Wood, 1933; Hibbard and Dalquest, 1966,

Table 5. Measurements (mm) of $P_{\overline{4}}$ of *Cynomys* cf. *C. ludovicianus* from Riddell Site compared with measurements of cheek-teeth of *Cynomys ludovicianus*, *C. gunnisoni*, *C. spiepiza*, and *C. leucurus* taken from Green (1960), Dalquest (1965), and Semken (1966).

Dimension	*Cynomys* cf. *C. ludovicianus*, VMS4	*C. ludovicianus* (Dalquest, 1965)	*C. ludovicianus* (Semken, 1966, UMMP 45355)	*C.* cf. *gunnisoni* (Semken, 1966, UMMP 50463)	*C.* cf. *gunnisoni* (Semken, 1966, UMMP 50494)	*C. spiepiza* (Green, 1960, SDSM 57100)	*C. leucurus* (Green, 1960, CUM 128)	*C. ludovicianus* (Green, 1960, CUM 3176)
$P_{\overline{4}}$ maximum mesiodistal diameter	3.2	3.2	3.0	2.9	2.9	3.0	2.5	3.0
$P_{\overline{4}}$ maximum buccolingual diameter	4.3	3.9	4.1	3.5		4.5	3.7	4.3
$M_{\overline{1}}$ maximum mesiodistal diameter		3.0	2.8	2.6	2.6	2.9	2.4	3.3
$M_{\overline{1}}$ maximum buccolingual diameter		4.0	4.8	4.0	3.9	4.7	3.4	4.0
$M_{\overline{2}}$ maximum mesiodistal diameter		3.3	3.1	3.0	2.7			
$M_{\overline{2}}$ maximum buccolingual diameter		4.5	5.1	4.5	4.1	3.0	2.5	3.0
$M_{\overline{3}}$ maximum mesiodistal diameter		4.3			4.3	4.9	4.7	5.7
$M_{\overline{3}}$ maximum buccolingual diameter		4.5			3.7	4.2	3.6	4.0

p. 8; Hibbard, 1970, Table 4). Wood's original description of *C. ludovicianus* from these deposits has not been challenged although several other Pleistocene species have subsequently been reported (see Hay, 1921, p. 615; Green, 1960, 1963; Hibbard, 1956, p. 172). That occurrence implies a long and conservative history for *C. ludovicianus* relative to other species of *Cynomys*. The fossil from Riddell Site is tentatively assigned to *Cynomys (Cynomys) ludovicianus* with the understanding that when better samples are recovered, and the affinities of the fossil species are better defined, a re-assessment can be attempted.

The known geographical range of *Cynomys ludovicianus* in Canada includes the extant form at Val Marie, Saskatchewan (the most northerly record of living prairie dog) and fossil forms from deposits of assigned Yarmouth and younger age of Medicine Hat, Alberta (Russell and Churcher, 1972, p. 18) and of uncertain Pleistocene age of the Hand Hills Formation, Delia, Alberta (Storer, 1975). The present report extends the range considerably northward and eastward.

Palaeoecological Implications

Modern *Cynomys ludovicianus* occupies a narrow band of dry plains from central Texas northward, extending just into Saskatchewan, and west of the 100th meridian. The prairie dog does not require a source of free water as it gets its moisture from plant tissues. At present the species occupies a relatively restricted range on open, level, arid, short-grass plains, living on river-flats and coulee bottomlands where greasewood and prickly pear grow, avoiding wet lands and shrubby areas (Banfield, 1974, p. 131). It also occurs on the tops of buttes, and on higher, well-drained sites. Schultz (1965, p. 248) commented that the black-tailed prairie dog prefers thick soil for its burrows.

Although the modern range of *Cynomys ludovicianus* in Canada is restricted, apparently by climatic controls, its range in the past, as indicated by the fossil record, was more extensive. The present report from Riddell Site is the most northerly known to date.

FAMILY GEOMYIDAE

Thomomys talpoides (Richardson), 1828

Fig. 9

Geological Range

?Late Rancholabrean - Recent (Illinoian - Holocene).

Material

$RP^{\overline{4}}$ (VM49); incomplete $RP^{\overline{4}}$ (VM50); $LI_{\overline{1}}$ (VM53); $LP_{\overline{4}}$ (VM48); $LM_{\overline{1}}$ or $LM_{\overline{2}}$ (VM51, VM359); partial molar (VM52).

Discussion

The recovered fossil specimens have been compared to specimens of extant *Thomomys talpoides* and are indistinguishable from them. The teeth are characterized by the presence of enamel on the posterior face of the upper premolar and by the absence or near absence of cementum in the re-entrant angles as in the genus *Thomomys* (Hall and Kelson, 1959; p. 412; Akersten, 1973, p. 168).

Genus *Thomomys* is known from deposits of early Irvingtonian age in southwestern Saskatchewan (Aftonian Wellsch Valley local fauna; Stalker and Churcher, in press) and from the latest Irvingtonian

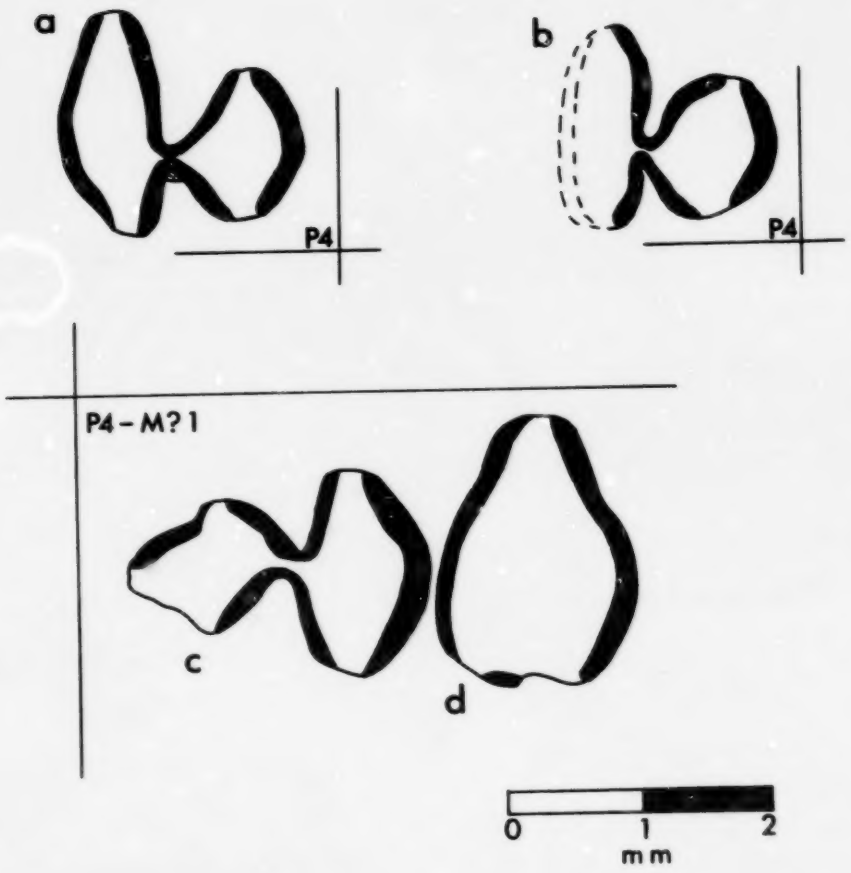

Fig. 9. Cheek-teeth of *Thomomys talpoides* (a, VM49, $RP\frac{4}{}$; b, VM50, partial $RP\frac{4}{}$; c, VM48, $LP\frac{}{4}$; d, VM359, $LM\frac{}{1}$ or $LM\frac{}{2}$).

(Kansan; pre-Pearlette ash, Type O) Cudahy fauna of Kansas (Paulson, 1961, p. 137). The oldest specimens assigned to *Thomomys talpoides* are part of the Duck Creek local fauna of Kansas, assigned an Illinoian age (McMullen, 1978, p. 377).

Palaeoecological Implications

Thomomys talpoides, the northern pocket gopher, is widely distributed across the central plains and western mountains of North America. It is common in all three prairie provinces of Canada. The geographical range of the southern pocket gopher, *T. umbrinus*, extends southward from the range of *T. talpoides* (Hall and Kelson, 1959, p. 414-415 and p. 438-439).

Thomomys talpoides prefers thick, heavy, moist soil and moves close to sloughs and bluffs when higher areas begin to dry. Natural grasslands and riverbanks are favoured locations (Banfield, 1974, p. 149). The presence of this species in the fauna implies the presence of moist lowland near the site of deposition. It is a common element in the extant fauna of the Saskatoon area.

FAMILY CRICETIDAE

Clethrionomys gapperi (Vigors), 1830

Fig. 10

Geological Range

?Late Rancholabrean - Recent (Illinoian - Holocene).

Material

$RM\frac{1}{}$ (VM366); $LM\frac{2}{}$ (VM427); $LM_{\overline{1}}$ (VM370), partial $LM_{\overline{1}}$ (VM374); molar fragment (VM365).

Discussion

All recovered specimens assigned to *Clethrionomys gapperi* were compared with specimens of recent *C. gapperi* and are indistinguishable from similar teeth in similar stages of wear (Fig. 10). The fourth and fifth alternating triangles of $M_{\overline{1}}$ are strongly isolated by re-entrant angles and are not considered part of the anterior loop.

The earliest record of *Clethrionomys gapperi* in the Pleistocene of North America is from the Duck Creek local fauna, Ellis County, Kansas, believed to be of Illinoian age (Zakrzewski and Maxfield, 1971; McMullen, 1978, p. 378). Zakrzewski and Maxfield (1971) noted slight differences between the fossil

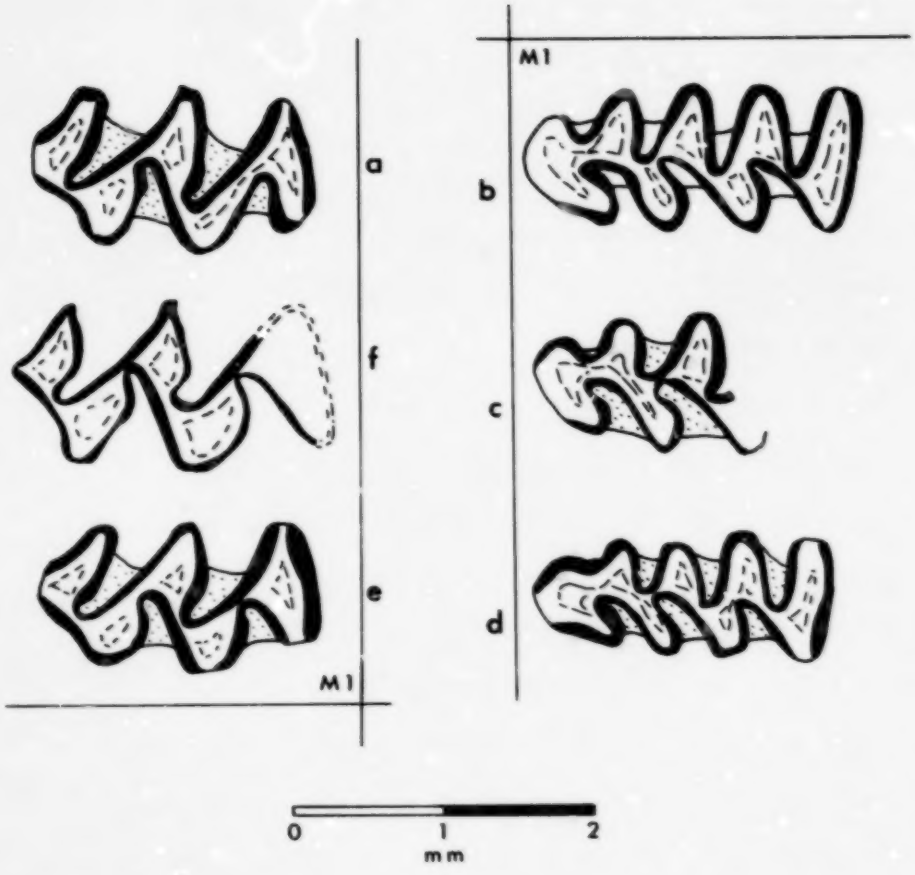

Fig. 10. First molar teeth of *Clethrionomys gapperi* (a-e) and *Phenacomys intermedius* (f) (a, VM366, $RM\frac{1}{}$; b, U. of S. Biology 2639, $RM\frac{1}{}$; c, VM370, $LM\frac{}{1}$; d, VM374, $LM\frac{}{1}$; e, U. of S. Biology 2639, $LM\frac{}{1}$; f, VM368, $RM\frac{1}{}$).

specimens of $M_{\overline{1}}$ and extant forms but they were unable to attribute these differences to specific variation. McMullen (1978, p. 378), on the basis of a larger collection, also assigned the Duck Creek specimens to *C. gapperi* but noted that most of the variation apparent in $M_{\overline{1}}$ teeth approaches the variation seen in extant specimens. Variable characteristics include the degree of closure of alternating triangles, the degree of isolation of the fourth and fifth alternating triangles and the resultant simplification of the anterior loop, and the presence or absence of cementum in the fourth lingual re-entrant angle.

An examination of specimens of extant *Clethrionomys gapperi* showed that the kind of variation in form described by Zakrzewski and Maxfield (1971) and McMullen (1978, p. 378) is also found in an extant population. However, because *C. gapperi* is not well known as a fossil species, intraspecific variability has not been documented. In Table 6, *C. gapperi* from Riddell Site is compared with the specimen recovered by Zakrzewski and Maxfield (1971).

Table 6. Measurements (mm) of $M_{\overline{1}}$ of *Clethrionomys gapperi* from Riddell Site compared with measurements of $M_{\overline{1}}$ referred to *C. gapperi* by Zakrzewski and Maxfield (1971).

Dimension	VM370	Zakrzewski and Maxfield, 1971 (SMM 13529)
Maximum mesiodistal diameter	2.50	2.54
Maximum buccolingual diameter	0.98	1.17

Palaeoecological Implications

Clethrionomys gapperi is found throughout Canada, except in Yukon and the Northwest Territories where it is replaced by *C. rutilis*. The range of *C. gapperi* in the western United States extends in a southerly direction from Washington, Idaho, and Montana into New Mexico and Arizona (Hall and Kelson, 1959, p. 715).

Clethrionomys gapperi prefers forest habitats, especially coniferous forests, where there is cover for foraging on the forest floor. The availability of water is an important factor to this species and it occurs where swamps and bogs or aspen bluffs and vegetated coulees are common (Banfield, 1974, p. 181). *C. gapperi* is common in the Saskatoon area today. Its presence in the Riddell local fauna suggests relatively wet rather than relatively dry conditions locally.

Phenacomys intermedius Merriam, 1889

Fig. 10

Geological Range

Late Irvingtonian - Recent (?Kansan - Holocene).

Material

Incomplete RM$\underline{1}$ (VM368), partial ?M$\underline{1}$ (VM364, VM367, VM369, VM371, VM372, VM375); partial ?M$\underline{2}$ (VM428); incomplete LM$\underline{3}$ (VM373); incomplete M$_{\overline{1}}$ (VM31).

Discussion

The specimens recovered from Riddell Site and referred to *Phenacomys intermedius* have been identified on the development of roots and the absence of cementum in the re-entrant angles. The development of a pocketed incipient re-entrant angle on M$\underline{1}$ confirms the identification.

Phenacomys has been considered a taxon endemic to North America, presumably having evolved here from a late Pliocene form *Pliophenacomys* (Hibbard, 1970, p. 400; Guilday and Parmalee, 1972). Recent evidence, however, indicates that *Phenacomys* is an Asian immigrant into North America first appearing in late Irvingtonian faunas. The arrival of *Phenacomys* in North America coincides with a time of arvicoline dispersal across the Bering Strait and its presence is used to date the beginning of late Irvingtonian time (about 1.2 million years B.P.) in North America (Repenning, 1978, p. 31).

Palaeoecological Implications

Phenacomys intermedius, the heather vole, is distributed across north-central Canada occurring primarily in the region of the Canadian Shield, and in the mountains of British Columbia. Its range extends southward in the Rocky Mountains into New Mexico. However, it is not found in the High Arctic (Banfield, 1974, p. 193).

Phenacomys intermedius is widely adaptable, most common in the shrubby and heather environments of dry, open coniferous forests or in the moist meadows and shrub borders of deciduous forests. It subsists largely on berries, seeds, foliage, and bark. Because it seldom eats grasses it does not occur in grassland habitats. *P. intermedius* is not common in the Saskatoon area today but it does occur in the coniferous forests of northern Saskatchewan.

Microtus cf. *M. (Microtus) pennsylvanicus*

(Ord), 1815

Fig. 11

Geological Range

?Late Rancholabrean - Recent (Illinoian -

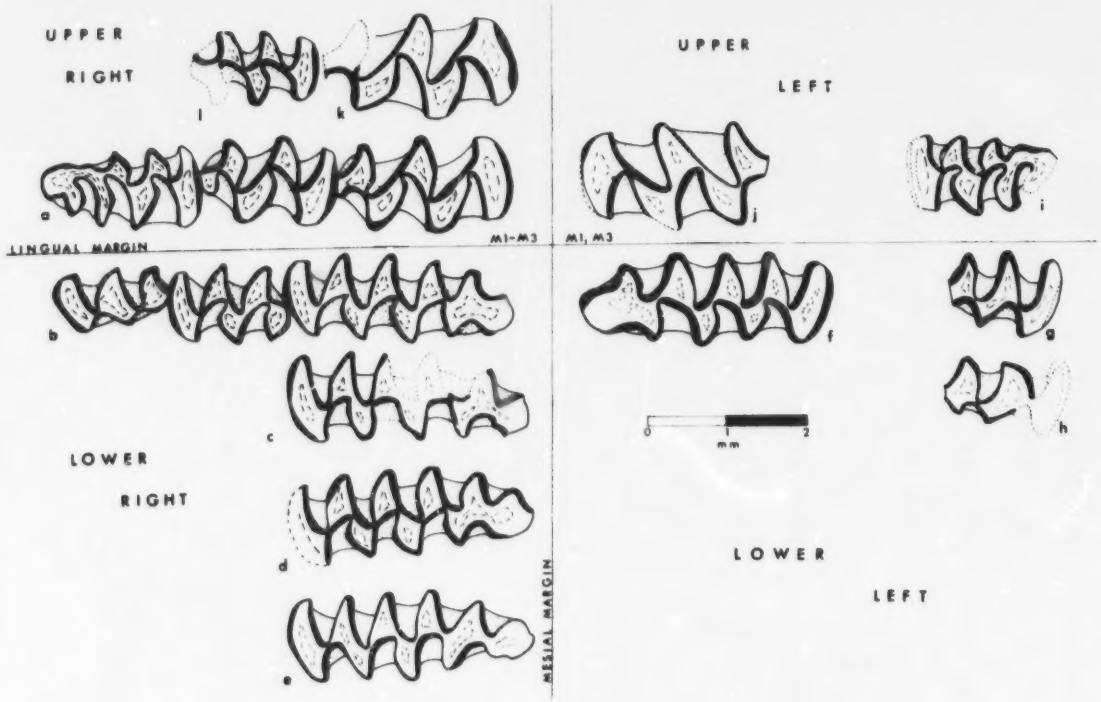

Fig. 11. Cheek-teeth of *Microtus* cf. *M. pennsylvanicus* (a, U. of S. Biology 1733, $RM\frac{1}{-}$ - $RM\frac{3}{-}$; b, U. of S. Biology 1733, $RM\frac{-}{1}$ - $RM\frac{-}{3}$; c, VM22, $RM\frac{-}{1}$; d, VM24, $RM\frac{-}{1}$; e, VM23, $RM\frac{-}{1}$; f, VM20, $LM\frac{-}{1}$; g, VM41, $LM\frac{-}{3}$; h, VM42, $LM\frac{-}{3}$; i, VM45, $LM\frac{3}{-}$; j, VM32, $LM\frac{1}{-}$; k, VM35, $RM\frac{1}{-}$; l, VM40, $RM\frac{2}{-}$).

Holocene).

Material

$LM^{\overline{1}}$ (VM32, VM390), incomplete $RM^{\overline{1}}$ (VM35, VM40); partial $LM^{\overline{3}}$ (VM45, VM46); $LM_{\overline{1}}$ (VM20), $RM_{\overline{1}}$ (VM22, VM23), incomplete $RM_{\overline{1}}$ (VM24, VM25), partial $RM_{\overline{1}}$ (VM28, VM29, VM30); $LM_{\overline{3}}$ (VM41), partial $LM_{\overline{3}}$ (VM42).

Discussion

The specimens from Riddell Site assigned to *Microtus* cf. *M. pennsylvanicus* have been compared with specimens of extant *Microtus pennsylvanicus*. The amount of variation in size and morpholcgy seen in the fossil specimens is also apparent in the extant specimens. In addition, a right lower first molar, $RM_{\overline{1}}$ (VM23), is unusual in that it has the first and second triangles open and confluent, rather than closed as is typical of *M. pennsylvanicus*. The posterior loop and portion of the tooth anterior to the second triangle are indistinguishable from typical lower first molars of *Microtus pennsylvanicus*. This is similar to the condition seen in an atypical juvenile specimen of recent *M. pennsylvanicus* (University of Saskatchewan Biology Museum 721) which

has open and confluent first and second triangles on the lower first molars. Because the structure of the alternating triangles is similar to the latter specimen, the fossil specimen has been assigned to *Microtus* cf. *M. pennsylvanicus*.

Guthrie (1965) and Semken (1966, p. 160) accepted that $M_{\overline{1}}$ is a diagnostic element and showed that in the *Microtus paroperarius - Microtus pennsylvanicus* line the number of closed, alternating triangles on $M_{\overline{1}}$ increases through time. Moreover, the percentage, in a population, of $M_{\overline{1}}$ teeth having an increased number of closed triangles increases through time. In addition, Semken (1966, p. 160) presented evidence that this character may vary with geographical distribution. It appears that the number of closed triangles on $M_{\overline{1}}$ in populations of *M. pennsylvanicus* is greater in populations from the western plains than in populations from the eastern plains. Similarly, the percentage of individuals, with an increased number of closed triangles, in a population is greater. This increase in number of closed triangles and percentage in a population appears to be gradational and progressive. Populations of *M.*

pennsylvanicus from eastern forested regions have the smallest number of closed, alternating triangles on $M_{\overline{1}}$ and the smallest percentage of individuals showing an increased number of closed triangles.

Four out of five specimens of $M_{\overline{1}}$ recovered from Riddell Site are composed of five alternating, closed triangles followed by two open to confluent triangles which are more or less continuous with the anterior loop. This condition is the one most commonly seen in specimens of recent *Microtus pennsylvanicus*, as reported by Semken (1966, p. 160) who noted this condition in 60 per cent of the specimens he examined.

The upper second molar is also diagnostic of *Microtus pennsylvanicus* and is believed to be sufficiently distinctive in about 90 per cent of a given population that without its presence in a sample specific assignment cannot be certain (Repenning, personal communication, 1978). The specimens recovered from Riddell Site strongly resemble *M. montanus* and on morphological grounds, assignment to *M. montanus* is suggested (Repenning, personal communication, 1978). Present ranges, however, favour assignment of the recovered specimens

to *M. pennsylvanicus*. Therefore, in the absence of any upper second molars assignable to *M. pennsylvanicus* from Riddell Site, and on the dubious basis of present distribution, the recovered specimens are referred to *Microtus* cf. *M. (Microtus) pennsylvanicus*.

Genus *Microtus* is an Asian immigrant into North America and its appearance in North America marks the beginning of the Irvingtonian land mammal age (Repenning, 1978, p. 51). Paulson (1961, p. 144 - 146) and Guthrie (1965) have demonstrated that arvicoline rodents of the *Microtus pennsylvanicus* line evolved rapidly since Kansan time (*i.e.* during Rancholabrean time), and that variability is high in extant populations. Evidence available to date suggests that the variability is both spatial and temporal. Biostratigraphical and palaeoecological study is limited because numbers of specimens in any one sample are usually inadequate; moreover, such a study may not be productive because of the inherent variability of the population.

Palaeoecological Implications

Microtus pennsylvanicus is found throughout Canada. It is absent only in the extreme Arctic

and in the coastal mountains of British Columbia. Its range extends across the northern half of the United States. Wet meadows are the preferred habitat of the meadow vole but it will also inhabit any grassland habitat (Banfield, 1974, p. 209 - 210).

Microtus pennsylvanicus is common in the Saskatoon area today. It is a highly adaptable animal living on drier uplands in the absence of competition from allopatric species, and restricted to wetter meadows by competition.

Microtus sp.

Fig. 12

Geological Range

?Irvingtonian - Recent (?Aftonian - Holocene).

Material

Palate with $RM\frac{1}{-}$ and $RM\frac{2}{-}$ (VM47); $LM\frac{1}{-}$ (VM33), $RM\frac{1}{-}$ (VM34, VM36); $RM\frac{2}{-}$ (VM16, VM38); $LM_{\frac{-}{2}}$ (VM37, VM39).

Discussion

The specimens assigned here are sufficiently distinctive to warrant an assignment separate from *Microtus* cf. *M. pennsylvanicus*. They indicate that more than one species of *Microtus* may be represented

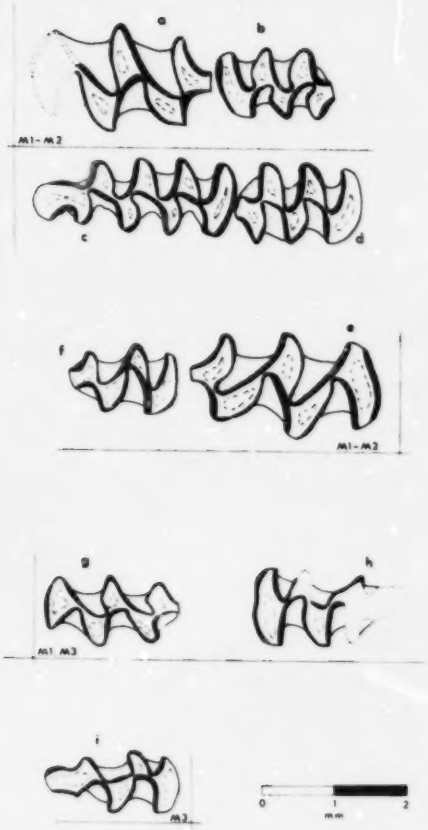

Fig. 12. Cheek-teeth of *Microtus* sp. (a-f) and *Lagurus curtatus* (g-i) (a, VM33, $LM\frac{1}{}$; b, VM36, $LM\frac{2}{}$; c, VM19, $LM_{\overline{1}}$; d, VM37, $LM_{\overline{2}}$; e, VM34, $RM\frac{1}{}$; f, VM16, $RM\frac{2}{}$; g, VM426, $LM\frac{1}{}$; h, VM44, $LM\frac{3}{}$; i, VM17, $RM\frac{3}{}$).

in the Riddell local fauna.

At the present time only two species of *Microtus*, *M. pennsylvanicus* and *M. (Pedomys) ochragaster*, are sympatric in the Saskatoon area. The material presented here is not assignable to *M. ochrogaster* and no specimens referable to that species have been recovered.

Lagurus curtatus (Cope), 1868

Fig. 12

Geological Range

?Late Rancholabrean - Recent (?Illinoian - Holocene).

Material

$LM\frac{1}{-}$ (VM426); $RM\frac{3}{-}$ (VM17), incomplete $LM\frac{3}{-}$ (VM44); $LM_{\overline{1}}$ (VM19), incomplete $LM_{\overline{1}}$ (VM21), partial $RM_{\overline{1}}$ (VM26).

Discussion

Lagurus curtatus is poorly represented in the Riddell local fauna. It is identified on the conformation of $M\frac{3}{-}$ and $M_{\overline{1}}$.

Lagurus, an Eurasian genus that migrated into North America about 600 000 years B.P. with *Clethrionomys*, and several species of *Microtus*, has been

used to mark the end of the Irvingtonian land mammal age and the beginning of the Rancholabrean land mammal age (Repenning, 1978, p. 51). Because there have been no reports of *Lagurus* from early Rancholabrean faunas *Lagurus* is now believed to be a late Rancholabrean (±175 000 years B.P.) immigrant to North America (Repenning, personal communication, 1979). This late date of migration makes *L. curtatus* a significant biostratigraphical component in the Riddell local fauna.

Palaeoecological Implications

Lagurus curtatus, the sagebrush vole, inhabits the arid short-grass, sagebrush prairie and mountains of central North America. In Canada it inhabits the arid regions of southeastern Alberta and adjoining southwestern Saskatchewan. Its range extends southward and westward into adjacent portions of Montana, Wyoming, Colorado, Utah, Idaho, Oregon, and Washington. Sagebrush is the primary component in the diet of *L. curtatus*.

The sagebrush vole does not occur in the Saskatoon area today. However, the current

restriction to a narrow habitat cannot be safely extrapolated back in time because the migratory and evolutionary patterns of this vole have not yet been adequately documented, and because the sagebrush-habitat was once more widespread than it is at present (*e.g.* Wright, 1970).

Ondatra zibethicus (Linnaeus), 1766

Fig. 13

Geological Range

Late Rancholabrean - Recent (Illinoian - Holocene).

Material

$RM\underline{^2}$ (VM203).

Discussion

The recovered specimen was compared with $M\underline{^2}$ teeth of fifteen specimens of extant *Ondatra zibethicus* and measurements are provided in Table 7. The $RM\underline{^2}$ falls within the lower limits of the observed range of extant *Ondatra zibethicus*. Examination of the recent specimens suggests that dimensions of the occlusal surface increase with wear and age; the more heavily worn specimens are both longer and wider

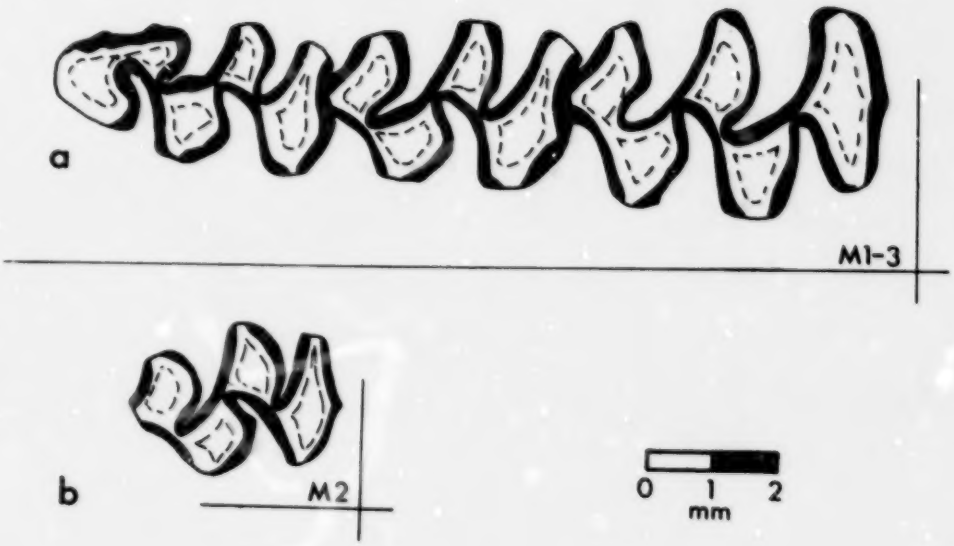

Fig. 13. Comparison of cheek-teeth of extant *Ondatra zibethicus* (a, U. of S. Biology 2714, $RM\frac{1}{-}$ - $RM\frac{3}{-}$) and of *Ondatra zibethicus* from Riddell Site (b, VM203, $RM\frac{2}{-}$).

Table 7. Measurements (mm) of $M^{\underline{2}}$ of *Ondatra zibethicus* from Riddell Site compared with measurements of $M^{\underline{2}}$ teeth of recent *Ondatra zibethicus* and of *O. zibethica* [sic] reported by Hibbard (1943) from the Rezabek fauna of Lincoln County, Kansas.

		Ondatra zibethicus			Hibbard
Dimension	VM203	N	$\bar{X}$	Min.-Max.	1943
Maximum mesiodistal diameter	3.40	28	3.70	3.25-4.10	3.6
Maximum buccolingual diameter	2.45	28	2.70	2.45-2.90	

than the less heavily worn ones. The recovered specimen is a well-worn tooth with a strongly interrupted enamel pattern. The size of this tooth matches more closely recent specimens whose teeth are considerably less well worn.

The muskrat (*Ondatra* spp.) is common in Pleistocene faunas beginning 2.5 million years B.P. (*e.g.* Hibbard, 1970). The taxonomically diagnostic element is the lower first molar ($M_{\overline{1}}$) and such characteristics as overall size, height of the first buccal dentine tract, and amount of cementum in re-entrant angles have been used for interspecific diagnosis (Hollister, 1911; Hibbard, 1955a, 1959; Stephens, 1960). More recently it has been shown that statistical analyses of length to width ratios of $M_{\overline{1}}$ of populations of muskrats are a reliable means of separating species and interpreting palaeoenvironments, and are useful in distinguishing between interglacial and glacial faunas (Semken, 1966; Nelson and Semken, 1970; Martin and Tedesco, 1976).

The earliest report of *Ondatra zibethicus* is from deposits of assigned Illinoian age. Hibbard (1943) referred material from the Rezabek fauna of

Kansas to *Ondatra zibethica* [sic]. A small species, *O. triradicatus*, described by Starrett (1956) from the Berends local fauna of Oklahoma (Illinoian) cannot be distinguished from *O. zibethicus* (Stephens, 1960; Semken, 1966, p. 154). McMullen (1978, p. 380) referred specimens from the Duck Creek local fauna of Kansas (Illinoian) to *Ondatra zibethicus* because his data suggested that the degree of development of the dentine tract on $M_{\overline{1}}$ approached the condition seen in latest Pleistocene and modern specimens.

Palaeoecological Implications

The muskrat is an amphibious rodent requiring the presence of permanent aquatic environments. It is widespread in North America occurring everywhere except in the Arctic tundra, the arid regions of the American southwest, and along the Gulf Coast. It will occupy any aquatic habitat provided that the water is sufficiently deep so as not to freeze to the bottom and provided that there is submerged vegetation available.

If fossil remains of *Ondatra zibethicus* are present in a deposit, but are rare, the only palaeontological information provided is that a permanent

body of water was present. If a large number of specimens, primarily $M_{\overline{1}}$, were available statistical analyses would be feasible. Were such analyses possible *Ondatra zibethicus* could be a useful palaeoecological and biostratigraphical indicator.

ORDER CARNIVORA

FAMILY CANIDAE

Canis cf. *C. latrans* Say, 1823

Fig. 14

Geological Range

Rancholabrean - Recent (Kansan - Holocene).

Material

$LI^{\overline{2}}$ (VM15).

Discussion

The recovered specimen is incomplete, missing the anteromedial corner. That the specimen derives from an old adult is indicated by its advanced stage of wear. The central and mesial cones are worn flat, forming a single wear facet. The cingulum, too, is heavily worn; the wear facet is V-shaped and extends to within 0.5 mm of the base of the tooth crown.

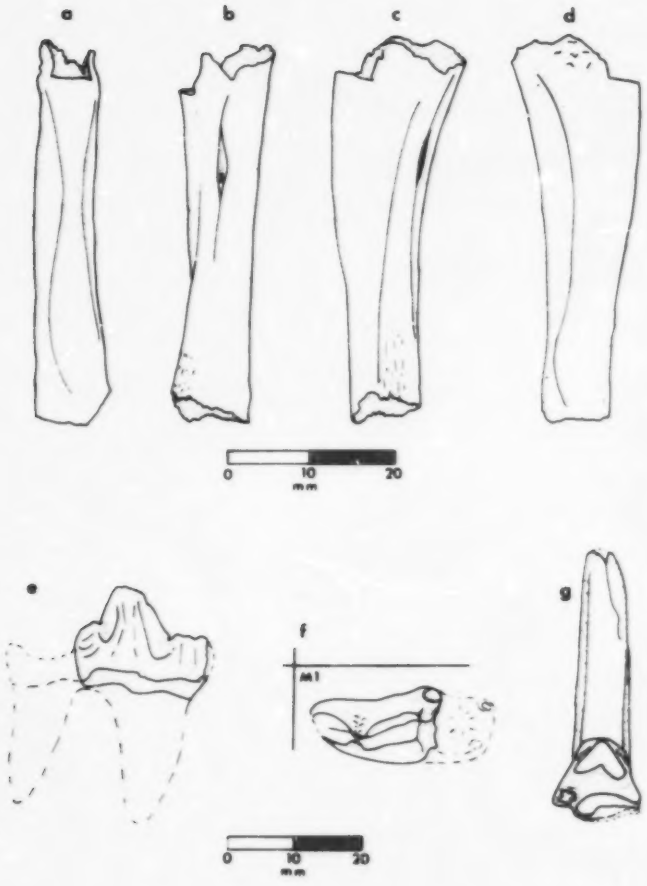

Fig. 14. Left tibia, shaft fragment (a-d) and partial $LM_{\overline{1}}$ (e-f) of *Vulpes* cf. *V. vulpes*, and incisor (g) of *Canis* cf. *C. latrans* (a, VM14, anterior aspect; b, VM14, posterior aspect; c, VM14, lateral aspect; d, VM14, medial aspect; e, VM13, lingual aspect; f, VM13, occlusal aspect; g, VM15, lingual aspect).

The fossil was compared with recent specimens. None of the latter display as advanced a stage of wear as the recovered specimen. The size and general morphology of the recovered specimen compares best with similar teeth of *Canis latrans*; *C. lupus* has much larger incisors; the incisors of *Vulpes* are more lobed and are much smaller.

Canis is known throughout the Pliocene and Pleistocene and *Canis* cf. *C. latrans* is first reported from the Gilliland fauna in Texas (Hibbard, 1970, Table 4); the earliest *Canis* reported from the Canadian prairies is *Canis ?etruscus* from near Medicine Hat, Alberta of assigned Kansan age (Russell and Churcher, 1972, p. 17).

Palaeoecological Implications

Canis latrans lives virtually everywhere on the North American continent, ranging from northern Alaska to Central America (Hall and Kelson, 1959, p. 845). It is absent only in the Canadian Shield and in Appalachia but its range appears to be continually expanding into these regions (Banfield, 1974, p. 289). It is highly adaptable and co-exists readily with man. In general, however, coyotes seem to prefer

hilly country with poplar bluffs and willow-lined stream banks. They feed primarily on small mammals and carrion as well as human garbage.

Canis latrans is a common element in the extant mammalian fauna of the Saskatoon area. Because of its adaptability *Canis* cf. *C. latrans* is an entirely expected element in a prairie Pleistocene fauna.

Vulpes cf. *V. vulpes* (Linnaeus), 1758

Fig. 14

Geological Range

?Rancholabrean - Recent (?Illinoian - Holocene).

Material

Incomplete $LM_{\overline{1}}$ (VM13); partial left tibia (VM14).

Discussion

The referred specimens have been compared with specimens of recent *Canis latrans*, *Vulpes fulva* (see below), and *Alopex lagopus*. Although both specimens are incomplete they compare best in size and morphology to *Vulpes* and both are indistinguishable from that taxon. The recovered specimens are assigned to *Vulpes* cf. *V. vulpes* following Churcher

(1959) who concluded that *V. vulpes* and *V. fulva* are conspecific.

Genus *Vulpes* is an old taxon. It had its origins in the Tertiary of North America and entered Europe in the late Pliocene. The oldest North American specimens assigned to *Vulpes vulpes* are of reported Sangamon age from deposits near Medicine Hat, Alberta (Russell and Churcher, 1972, p. 18). In Kansas and Oklahoma fossil *Vulpes vulpes* is known only from Wisconsin deposits (Hibbard, 1970, Table 8). However, the native fox of the Central Plains of the United States, *Vulpes velox*, is known from as early as Illinoian time (Hibbard, 1970, Table 6).

Palaeoecological Implications

The red fox, *Vulpes vulpes*, is widespread in North America, absent only from some of the Arctic Islands and in southern parts of Florida, Texas, New Mexico, Arizona, and California. It is continuing to compete successfully with resident species of foxes. The known range of the red fox has now expanded to include some Arctic Islands, and the semi-arid central plains southward toward the Gulf Coast of Mexico displacing native species of foxes

(Hall and Kelson, 1959, p. 856; Banfield, 1974, p. 300).

Red foxes are most prevalent in semi-open country and natural clearings in forests. The principal source of food, in areas removed from the influence of man, is small mammals. Like the coyote, the red fox is highly adaptable and is an expected element in a Pleistocene vertebrate fauna.

ORDER PROBOSCIDEA

Proboscidea gen. and sp. indet.

Material

Large indeterminate fragments (VM243, ?VM321).

Discussion

The material is referred to Proboscidea because of its large size and massive structure. It is too fragmentary to allow even identification of the element represented. Because the material is so fragmentary there is the possibility that sloth (Xenarthra) may be represented here. The present assignment is supported by the reports of Proboscidea in similar deposits in the Saskatoon area (Russell, 1943; Lammers, 1968), although *Megalonyx* has also been recovered (Churcher, personal communication, 1978).

ORDER PERISSODACTYLA

FAMILY EQUIDAE

Equus conversidens Owen, 1869

Fig. 15

Geological Range

?Irvingtonian - post-glacial (?Nebraskan - early Holocene).

Material

Skull fragments, occiput (VM357); fragmentary premaxilla with $LI\frac{1}{}$, $LI\frac{2}{}$, $RI\frac{1-3}{}$ (VM341); coronoid and condylar processes of right mandible (VM308); incisor - $RI\frac{1}{}$ (VM379), $?LI\frac{2}{}$ (VM378), $?LI\frac{3}{}$ (VM308); upper cheek-teeth - Rdp (VM249, VM358), Ldp (VM361), LP or LM (VM362), $LM\frac{3}{}$ (VM250); lower cheek-teeth - $?dp\frac{}{3}$ (VM363), $RP\frac{}{2}$ (VM377), $?LM\frac{}{1}$ (VM376), $?RM\frac{}{1}$ (VM248), $LM\frac{}{1}$ - $LM\frac{}{3}$ (VM247); tooth fragments (VM251, VM331, VM380, VM381); atlas (VM391); incomplete right scapula (VM322, VM352); humerus - distal portion of left (VM253), distal portion of right (VM344); radius - distal end of left (VM382), proximal portion of right (VM383); left distal radial epiphysis (VM262, VM392); left radio-ulna (VM384); right ulna (VM298); os innominatum - portion of left ilium (VM282, VM339), portion of left iliac including acetabular

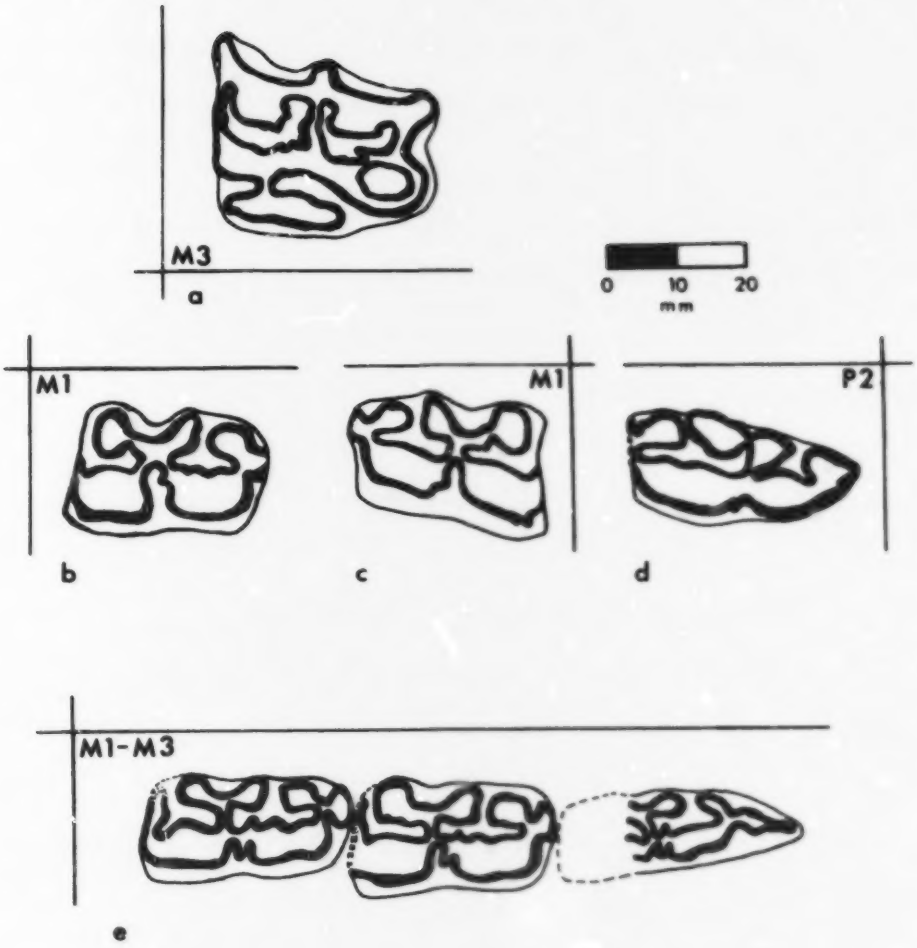

Fig. 15. Cheek-teeth of *Equus conversidens* from Riddell Site (a, VM250, $LM^{\overline{3}}$; b, VM376, $LM_{\overline{1}}$; c, VM248, $RM_{\overline{1}}$; d, VM377, $RP_{\overline{2}}$; e, VM247, $LM_{\overline{1}}$ - $LM_{\overline{3}}$).

fossa (VM299), fragments (VM389); femur - left (VM385), left juvenile (VM386), portion of left shaft bearing supracondyloid fossa (VM288), head of femur (VM309), proximomedial portion of right (VM281); tibia - incomplete right (VM387), distal half of left (VM252), proximal portion of shaft bearing nutrient foramen and muscle scars (VM388); left scaphoid (VM394); lunar - left (VM274, VM317, VM353), right (VM316, VM395, VM396, VM397); cuneiform - left (VM242, VM327, VM329), right (VM273, VM359); left pisiform (VM398); magnum - right (VM265, VM294), left (VM266); fused trapezoid and magnum (VM292); proximal sesamoid (VM271, VM272, VM293, VM314, VM324, VM348, VM399, VM400); right astragalus (VM295); calcaneum - right (?VM351, VM393), incomplete right (VM349); navicular - left (VM267, VM268, VM269, VM306), right (VM401, VM402); ectocuneiform - right (VM270, VM403), ?partial right (VM326); cuboid - right (VM330), left (VM275); metacarpal III - right (VM313), incomplete left (VM404); metatarsal III - proximal half of left (VM263, VM297); metapodial III - indeterminate (VM318), distal half (VM296, VM319), metapodial II or IV (VM304, VM305, ?VM335, VM405); proximal

phalanx - complete (VM258, VM259, VM260, VM312, VM406), juvenile (VM261), incomplete (VM407, VM408); medial phalanx - complete (VM254, VM255, VM256, VM257, VM325), juvenile (VM315, VM409), incomplete (VM334); indeterminate phalanx (VM410); ungual phalanx - complete (VM264), incomplete (VM323, VM340); sacrum - incomplete (VM300), left wing and portion distally of body (VM336), left wing (VM337, VM346); cervical vertebrae - incomplete (VM276, VM310, VM338), incomplete III or IV (VM412), incomplete V or VI (VM411), incomplete last cervical (VM343); thoracic vertebrae - distal thoracic (VM285, VM391), last thoracic (VM284); lumbar vertebrae - incomplete (VM413), incomplete ?VI (VM414); caudal vertebra (VM279).

Discussion

Equus conversidens is recognized on the basis of recovered cheek-teeth, metapodials, and phalanges. The other recovered specimens are referred here because their size is consistent with that of *E. conversidens* (Tables 8-15) and because they are associated depositionally with the more positively identified specimens.

Table 8. Measurements (mm) of upper incisors of *Equus conversidens* from Riddell Site compared with those of *Equus conversidens* from Cochrane, Alberta (Churcher, 1968, Table IV) and of *E.* cf. *conversidens* from Hand Hills, Alberta (Storer, 1976, Table 2).

	Equus conversidens						
Dimension	VM307	VM341 RI[2]	VM341 RI[3]	VM378	VM379	*Equus conversidens* (Churcher, 1968)	*E.* cf. *conversidens* (Storer, 1976, UA8523)
Mesiodistal diameter of occlusal surface	9.3	13.8	13e	12.0	14.0	13.9-22.2 (4)	14.5
Buccolingual diameter of occlusal surface	20.0	14e	16e	13.6	16.7	11.4-12.5 (5)	13.2
Direct length from occlusal buccal enamel margin to tip of root	NA		49e		52.7	56.0-68.7 (4)	49.1
Mesiodistal diameter of enamel infundibulum (=fossette)	6.5	NA	NA	NA	2.9	2.2-12.5 (5)	8.3
Buccolingual diameter of enamel infundibulum (=fossette)	16e	NA	NA	NA	2.2	1.8-6.0 (5)	5.2

e = estimate

NA = not applicable, character not present

number in parentheses represents sample size

Table 9. Measurements (mm) of a left upper third molar of *Equus conversidens* from Riddell Site compared with measurements of upper third molars of *Equus conversidens* reported by Hibbard (1955b, Table I, II, and III), Dalquest and Hughes (1965, Table 1), Dalquest (1967, Table 10), and Churcher (1968, Table III; 1972, Table 2).

Dimension	VM250	Hibbard, 1955b	Dalquest and Hughes, 1965 (P-182-1)	Dalquest, 1967	Churcher, 1968 (NMC 11588)	Churcher, 1972 (NMC 17846)
$M^{\underline{3}}$ mesiodistal diameter	32.3	20.6-24.9 (3)	27.2	23.3-24.5 (2)	27.5e	27.4
$M^{\underline{3}}$ buccolingual diameter	28.6	17.2-19.0 (3)	22.0	18.3-20.6 (2)	24.0	22.6

e = estimate

number in parentheses represents sample size

Table 10. Measurements (mm) of lower cheek-teeth of *Equus conversidens* from Riddell Site compared with measurements of lower cheek-teeth of *Equus conversidens* reported by Dalquest (1964; 1967, Table 12), Dalquest and Hughes (1965, Table 2), and Churcher (1975, Table I).

	VM377	VM247			VM248	VM376	Dalquest, 1964 (MU 2819)			Churcher, 1975 (ROM 13059)	
Dimension	$RP_{\overline{2}}$	$LM_{\overline{1}}$	$LM_{\overline{2}}$	$LM_{\overline{3}}$	$?RM_{\overline{1}}$	$?LM_{\overline{1}}$	$M_{\overline{1}}$	$M_{\overline{2}}$	$M_{\overline{3}}$	$P_{\overline{2}}$	$M_{\overline{1}}$
Mesiodistal diameter of occlusal surface	33.4	29.4	30.5	33.7	29.1	28.3	24.9	25.1	27.5	30.4	26.5
Buccolingual diameter of occlusal surface	16.6	17.7	16.0	13.3	19.8	19.1	14.4	13.5	11.9	18.3	17.5
Buccolingual diameter of enamel	15.3	14.7	13.7		17.2	17.0				15.0	17.0

e = estimate

number in parentheses represents sample size

Table 10. Measurements (mm) of lower cheek-teeth of *Equus conversidens*, continued.

Dimension	Dalquest, 1967				Dalquest and Hughes, 1965			
	$P_{\overline{2}}$	$M_{\overline{1}}$	$M_{\overline{2}}$	$M_{\overline{3}}$	$P_{\overline{2}}$	$M_{\overline{1}}$	$M_{\overline{2}}$	$M_{\overline{3}}$
Mesiodistal diameter of occlusal surface	28.3-32.6 (5)	23.0-26.9 (6)	21.4-27.1 (6)	25.4-34.5 (5)	27.4-29.5 (3)	22.2-23.3 (3)	21.4-24.0 (3)	25.4-29.8 (2)
Buccolingual diameter of occlusal surface	14.2-16.0 (5)	14.4-16.9 (6)	13.3-16.4 (6)	11.9-15.2 (5)	14.2-16.0 (3)	14.4-16.0 (3)	13.5-15.5 (3)	11.9-13.9 (2)
Buccolingual diameter of enamel								

The upper left third molar (VM250) is referred to *Equus conversidens* in spite of its large size (Table 9). Its morphological features are comparable to those of $M^{\underline{3}}$ of *E. conversidens* from Cochrane, Alberta described and illustrated by Churcher (1968, p. 1472 - 1475). Because of the advanced stage of wear of the specimen from Riddell Site the hypoconal groove has become closed forming a cementum filled hypofossette (or hypoconal fossette). Other features such as relative size and position of the protocone, shallow pli caballin, and shallow prefossette loop indistinct from the double pli prefossette are similar to characteristics of *Equus conversidens* (Hibbard, 1955b; Dalquest and Hughes, 1965, Dalquest, 1967; Storer, 1976, p. 194).

The lower cheek-teeth from Riddell Site indicate that plication of pre- and postfossettids becomes less pronounced with wear. This agrees with Churcher's (1975, p. 69) observation of specimens from Cochrane, Alberta. In addition, the ectoflexids are deep, extending to the level of the buccal wall of the pre- and postfossettids in less well-worn specimens and deeper lingually with advanced wear.

The pli caballinid decreases in size with wear.

Skinner (1972, p. 118 - 120) defined a series of isthmuses that join various cusps on the equid lower molar and contended that "The arrangement of the isthmuses on the lower molars readily separate hemionid and asinid groups from the zebrid and caballid horses (p. 120)". He found that in *Equus (Hemionus)* $M_{\overline{1}}$ and $M_{\overline{2}}$ have the protoconid united to the metastylid by a plain isthmus, the hypoconid to the posterior part of the protoconid-isthmus complex, and the metastylid, which is free from the hypoconid, united to the metaconid; the $M_{\overline{3}}$ usually has the same pattern but can occasionally, especially in *E. conversidens*, have the caballid type of junction (*i.e.* hypoconid-metastylid union).

The specimens of lower molars recovered from Riddell Site (Fig. 15) have the same type of isthmus pattern described for hemionid and asinid horses (Skinner, 1972, p. 120). On this basis assignment of the recovered specimens to *Equus conversidens* is supported.

Two taxa of equids, *Equus conversidens* and *E. niobrarensis - E. scotti*, have been reported from

Pleistocene deposits on the Canadian prairies (Russell, 1943; Lammers, 1968; Churcher, 1968, 1972, 1975; Churcher and Stalker, 1970; Khan, 1970; Russell and Churcher, 1972; Storer, 1976). However, only *E. niobrarensis* has previously been reported from the Floral Formation (Lammers, 1968). Russell's (1943) report is from uncertain provenance. Churcher (personal communication, 1978) found fragments from sand deposits north of Sutherland on the east side of the South Saskatchewan River which he assigned to *Equus* cf. *niobrarensis*. A review of these equid specimens is required as some specimens assigned to *E. niobrarensis* may well be referable to *Equus conversidens* (personal observation of fragmentary specimens assigned to *E. niobrarensis* by Russell, 1943, and now part of the vertebrate fossil collection of the Saskatchewan Museum of Natural History). Churcher (1968, p. 1486) made a similar observation regarding *E. scotti* material from Echo Lake, Saskatchewan. The equid material from the Saskatoon Site has not been examined and its identification as *E. niobrarensis* has not been confirmed.

Comparative measurements of selected post-cranial

elements assigned to *Equus conversidens* are provided in Tables 11 - 15. The specimens recovered from Riddell Site tend to be slightly larger than previously reported observed ranges.

The oldest specimens referred to *Equus conversidens* are from the early Pleistocene (Nebraskan) deposits of Brown County, Nebraska (Skinner, 1972, p. 123). All other reports of this species are of assigned Yarmouth to Wisconsin and post-glacial age.

Palaeoecological Implications

Equus conversidens is extinct in North America although it was extant well into post-glacial time. Churcher and Stalker (1970) referred horse material that is about 8000 years B.P. to *Equus conversidens*. This species was once widely distributed in North America, ranging from as far south as Mexico (Owen, 1869; Hibbard, 1955b) to at least as far north as Saskatoon and Edmonton (see Churcher, 1968, p. 1487, for a distribution map). *Equus conversidens* is believed to be either directly related to or conspecific with the extinct Mongolian kiang, *Equus (Hemionus) kiang* (Churcher and Stalker, 1970; Skinner, 1972).

Table 11. Measurements (mm) of metapodials of *Equus conversidens* from Riddell Site compared with measurements of metacarpals of *Equus conversidens* reported by Dalquest and Hughes (1965, Table 3), Dalquest (1967, Table 15) and Churcher (1968, Table X and XIII), and with measurements of metatarsals of *Equus conversidens* reported by Dalquest (1967, Table 15), Churcher (1968, Table XII), and Hager (1975, Table 16).

	Metacarpal	Metapodial indet.		?Metatarsals		
Dimension	VM313	VM296	VM319	VM263	VM292	VM404
Maximum length	219					
Maximum proximal width	45.6			45.1	51.4	52.4
Proximal anteroposterior depth	32.1			42.0	46e	44.5
Minimum width of shaft	31.7			30e		34e
Minimum depth of shaft	24.0			31e		47e
Maximum distal width	44.3	47.5	49.8			
Distal depth over condyle	35.6	37.2	38.1			

e = estimate

number in parentheses represents sample size

Table 11. Measurements (mm) of metapodials of *Equus conversidens*, continued.

Dimension	Metacarpals		
	Dalquest and Hughes, 1965	Dalquest, 1967	Churcher, 1968
Maximum length	218 -233 (5)	218 -233 (7)	203 -227.5 (7)
Maximum proximal width	45.0-53.4 (5)	47.7-53.4 (6)	41.3-49.5 (5)
Proximal anteroposterior depth			28.5-32.2 (6)
Minimum width of shaft	31.5-36.2 (5)	31.0-36.2 (7)	29.0-33.6 (9)
Minimum depth of shaft			21.0-27.5 (9)
Maximum distal width	43.5-49.0 (5)	43.5-49.0 (7)	39.0-46.9 (8)
Distal depth over condyle			35e -36.4 (2)

Table 11. Measurements (mm) of metapodials of *Equus conversidens*, continued.

	Metatarsals		
Dimension	Dalquest, 1967	Churcher, 1968	Hager, 1975
Maximum length	255 -264 (4)	247 -291 (7)	243
Maximum proximal width	46.7-49.0 (3)	42.2-49.5 (7)	44.5
Proximal anteroposterior depth		36.2-44.4 (7)	38.3
Minimum width of shaft	31.2-32.7 (4)	31.1-34.0 (7)	29.9
Minimum depth of shaft		28.5-33.3 (7)	25.7
Maximum distal width	42.3-47.0 (4)	41.5-50.7 (7)	39.3
Distal depth over condyle		29.0-38.4 (7)	33.1

Table 12. Measurements (mm) of astragalus of *Equus conversidens* from Riddell Site compared with measurements of astragali of *Equus conversidens* reported by Churcher and Stalker (1970, Table 1) from Pashley, Alberta, and by Storer (1976, Table 4) from Hand Hills, Alberta.

		Equus conversidens Churcher and Stalker, 1970			*Equus* cf. *conversidens* Storer, 1976
Dimension	VM295	(NMC 12444)	(MB-68-58)	(MB-68-170)	(NMC 9449)
Maximum transverse diameter of tibial trochlea	49e	50.0	49.1	48.7	51e
Maximum transverse diameter of central tarsal facet	47.1	51.5	51.5	49.4	53e
Maximum anteroposterior diameter	51e	52.3	51.5	51.3	56.7
Maximum proximodistal length between facets	54e	55.7	59.2	55.7	61

e = estimate

Table 13. Measurements (mm) of proximal phalanges of *Equus converidens* from Riddell Site compared with measurements of proximal phalanges of *Equus converidens* reported by Dalquest and Hughes (1965, Table 3 and 4), Dalquest (1967, Table 15), and Churcher (1968, Table X; 1972, Table 3).

Dimension	VM258	VM259	VM260	VM312	VM406	Dalquest and Hughes, 1965*	Dalquest, 1967*	Churcher, 1968, 1972 (manual)
Maximum proximodistal length	87.9	87.2	79.3	77.4	86e	78.5-89.0 (7)	75.9-89.0 (13)	75.8-83.8 (8)
Maximum proximal width	61.7	55.7	53.7	51.8		38.8-55.7 (6)	38.7-54.1 (9)	47.7e-56e (8)
Proximal anteroposterior diameter	37.1	37.6	38.0	35.6	36e			33.4-37.3 (8)
Minimum transverse diameter of shaft	35.6	36.4	34e	32.5	37e	23.8-32.7 (8)	23.8-32.7 (13)	30.5-33.6 (8)
Minimum anteroposterior diameter of shaft	21.9	21.2	18e	19.2	22e			17.7-20.5 (8)
Maximum distal width	43.0	44.3	40.2	41.0	43e	31.3-42.3 (8)	31.3-42.8 (13)	37.8-44.2 (8)
Distal anteroposterior diameter	25.8	25.9	23e	23.0	24e			21.1-24.2 (8)

* = combined measurements of manual and pedal phalanges

e = estimate

number in parentheses represents sample size

Table 14. Measurements (mm) of middle phalanges of *Equus conversidens* from Riddell Site compared with measurements of middle phalanges of *Equus conversidens* reported by Dalquest and Hughes (1965, Table 3 and 4), Dalquest (1967, Table 15), and Churcher (1968, Table X; 1972, Table 3).

Dimension	VM254	VM255	VM256	VM257	VM315	VM325	VM334	VM409
Maximum proximodistal length	44.6	48.6	50.1	49.7	44e	47.0		43e
Maximum proximal width	51.2	46.7	52.0	54.9	46.4	49.3	48.8	42e
Proximal anteroposterior diameter	30.4	32.0	30.8	32.7	28.9	29.1	29e	24e
Minimum transverse diameter of shaft	44.4	38.3	44.0	45.6	41.4	42.6	41e	38e
Minimum anteroposterior diameter of shaft	21.3	21.0	21.6	21e	19e	20e	19e	17e
Maximum distal width	47.7	41.2	47.5	48.6		41.5e		40e
Distal anteroposterior diameter	25.1	25.5e	24.5	26.8		21.5e		

* = combined measurements of manual and pedal phalanges

e = estimate

number in parentheses represents sample size

Table 14. Measurements (mm) of middle phalanges of *Equus conversidens*, continued.

Dimension	Dalquest and Hughes, 1965*	Dalquest, 1967*	Churcher, 1968, 1972 (manual)
Maximum proximodistal length	39.0-47.0 (8)	39.0-47.0 (9)	41.9-44.5 (3)
Maximum proximal width	37.1-50.9 (8)	36.1-50.9 (9)	43.7-48.7 (3)
Proximal anteroposterior diameter			24.8-29.4 (3)
Minimum transverse diameter of shaft	32.2-41.5 (8)	30.0-42.2 (9)	38.3-43.5 (5)
Minimum anteroposterior diameter of shaft			20.2-23.1 (5)
Maximum distal width	34.5-45.8 (8)	32.7-46.2 (9)	42e -46.9 (5)
Distal anteroposterior diameter			21.7-26.1 (5)

Table 15. Measurements (mm) of ungual phalanges of *Equus conversidens* from Riddell Site compared with measurements of ungual phalanges of *Equus conversidens* reported by Dalquest and Hughes (1965, Table 5), Dalquest (1967, Table 15), Churcher (1968, Table X), and Hager (1975, Table 16).

Dimension	VM264	VM323	Dalquest and Hughes, 1965*	Dalquest, 1967*	Churcher, 1968 (manual)	Hager, 1975
Maximum length	61e	67e	48.3-57.9 (4)	48.3-55.5 (5)	51.5e-55e (3)	30.7-49.1 (15)
Maximum transverse width	67.4	69e	45.2-64.9 (4)	45.2-65.8 (5)	63.9-68.6w (3)	37.8-69.5 (10)
Maximum height	40e	40e	33.5-39.8 (4)	34.7-40.7 (5)	35e-37.6 (3)	18.4-36.0 (16)

* = combined measurements of manual and pedal phalanges

e = estimate

w = worn specimen

number in parentheses represents sample size

The habitat of *Equus conversidens* was thought to be restricted to "southern prairie or subtropical - temperate woodland" (Churcher, 1968, p. 1486). However, its presence as far west and north as Calgary, Edmonton, and Saskatoon, and in the post-glacial gravels at Watino, on the Smoky River in the Peace River district (Churcher and Wilson, 1979, p. 73) suggests that it was equally well adapted to the northern prairie environment whether or not the climate was more equable than at present. Churcher (1968, p. 1486) suggested of *Equus conversidens* that " ... the species was widespread on the prairies or their margins." The recovery of material referable to *Equus conversidens* from Riddell Site supports Churcher's conclusion.

ORDER ARTIODACTYLA

FAMILY CAMELIDAE

Camelops cf. *C. hesternus* (Leidy), 1873

Fig. 16, 17

Geological Range

Rancholabrean - post-glacial (Kansan - early Holocene).

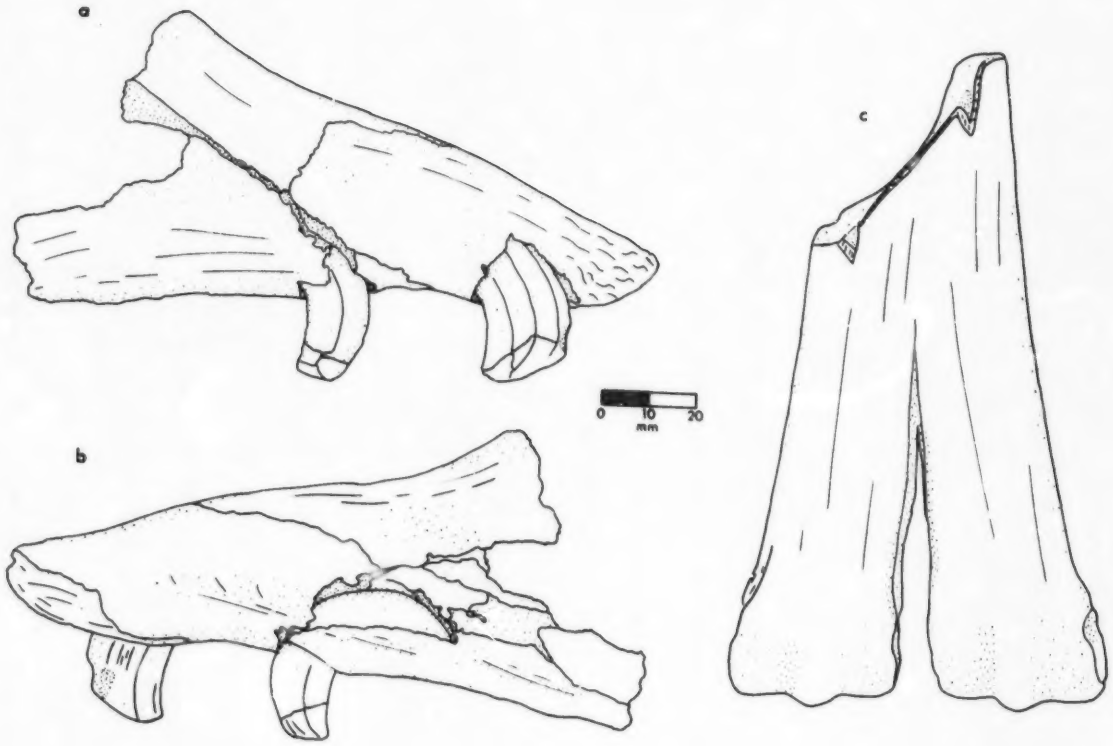

Fig. 16. Right premaxillary - maxillary fragment (a, VM1, lateral aspect; b, VM1, medial aspect) and metapodial (c, VM3, posterior aspect) of *Camelops* cf. *C. hesternus* from Riddell Site.

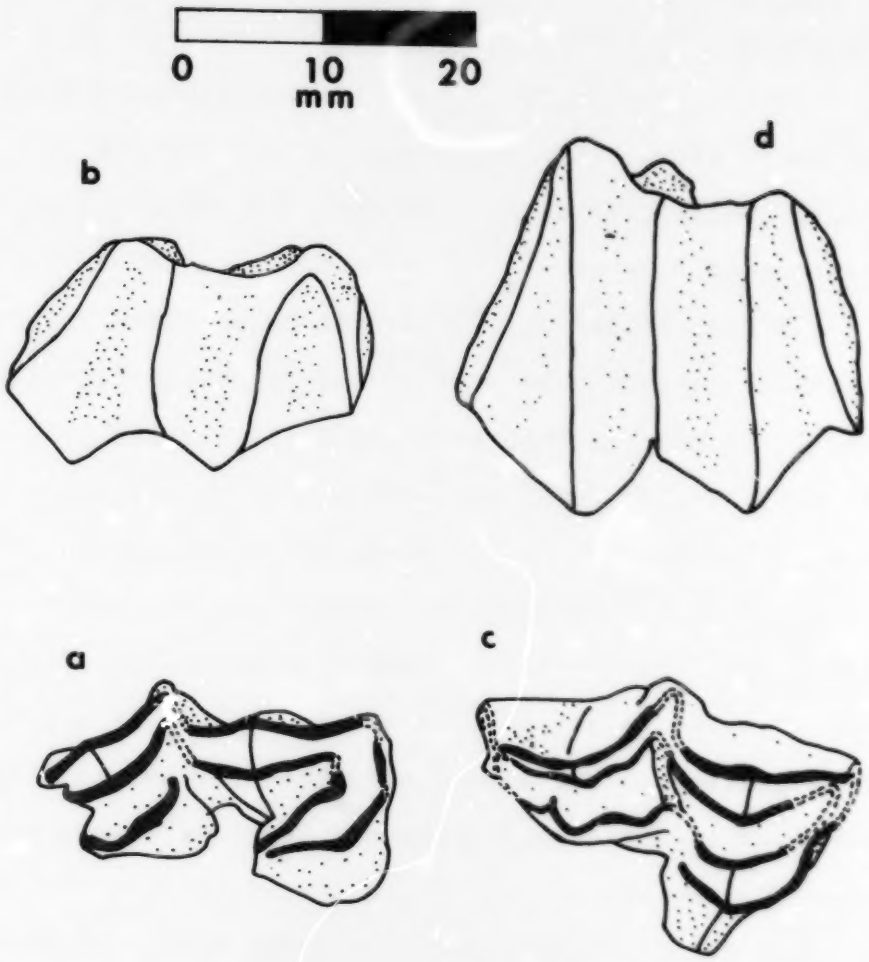

Fig. 17. Deciduous cheek-teeth of *Camelops* cf. *C. hesternus* from Riddell Site (a, VM2, right upper dp, occlusal aspect; b, VM2, right upper dp, buccal aspect; c, VM2, right upper dm, occlusal aspect; d, VM2, right upper dm, buccal aspect).

Material

Right premaxillary - maxillary fragment with $I\frac{3}{-}$ and C (VM1); ?two fragmentary, deciduous cheek-teeth (VM2); partial metapodials (VM3, VM4, VM5).

Discussion

A large camel is represented by a premaxillary - maxillary fragment bearing $I\frac{3}{-}$ and C. These teeth are worn, indicating that the fragment is derived from an adult individual. Abrasion of the anterior-most end of the premaxilla has partially obscured the presence of a well developed rugosity. The premaxillary - maxillary suture can be seen lingual to the anterior border of $I\frac{3}{-}$ crossing diagonally over the diastema to the labial border of C. The maxillary bone overlaps the premaxilla but the latter does not come in contact with C. The diastema between $I\frac{3}{-}$ and C is short (23.6 mm) and only ±60 mm of the C - $P\frac{3}{-}$ diastema is preserved.

The cranial fragment from Riddell Site is comparable to Leidy's (1854) type specimen of *Camelops kansanus (nomem dubium*, Webb, 1965, p. 3) illustrated by Merriam (1913, Fig. 10a, 10b). This portion of the skull possesses diagnostic features that

distinguish *Camelops* from other genera of camelids (Webb, 1965, p. 3).

Specific assignment of specimens of *Camelops* is usually difficult because "It is probable that generic characters of *Camelops* and the specific characters of the La Brea, California, *C. hesternus* have to some extent been confused" (Wilson and Churcher, 1978, p. 735). Two species of large camelids are recognized: *C. hesternus* and *C. huerfanensis*. They are distinguished on the basis of the character of the junction of the premaxillary - maxillary and nasal bones and on the development or absence of a premaxillary - nasal suture (Savage, 1951, p. 262 - 265; Hopkins, 1955). The length of the $I\frac{3}{}$ - C diastema appears to be a highly variable character (Table 16). However, Slaughter *et al.* (1962, p. 25) suggested that the large *Camelops* spp. are racial variants of a single species, and Wilson and Churcher (1978, p. 737) provided evidence that *Camelops hesternus* was more highly variable morphologically than was originally believed but were unable to determine whether the variation was phenotypic or geographical .

The two fragmentary cheek-teeth (VM2) have been

Table 16. Measurements (mm) of premaxillary - maxillary characteristics of *Camelops* cf. *C. hesternus* from Riddell Site compared with corresponding measurements of *Camelops hesternus* reported by Hopkins (1955) and Webb (1965, Table 5), and of *C. huerfanensis* reported by Lull (1921, p. 171) and Hopkins (1955, Table 1). Measurements given by Hopkins (1955) for *C. huerfanensis dallasi* (SMU 1.51) are those given by Lull (1921).

	Camelops cf. *C. hesternus*	*Camelops hesternus* (Webb, 1965)			
Dimension	VM1	(UCMP 20028)	(UCMP 20040)	(LACM Z252)	(LACM Z256)
$I\frac{3}{-}$ mesiodistal diameter	17.2		19.8	20.9	
$I\frac{3}{-}$ buccolingual diameter	12.0		10.0	13.7	
$C\frac{1}{-}$ mesiodistal diameter	12.3	14.0	13.7	19.8	
$C\frac{1}{-}$ buccolingual diameter	8.8	10.0	10.0	9.6	
Length diastema $I\frac{3}{-}$ - $C\frac{1}{-}$	23.6	36.8	42.3	66.5	23.4

* = measurement estimated by measuring and extrapolating from Lull's (1921, Fig. 4) illustration

Table 16. Measurements (mm) of premaxillary - maxillary characteristics of *Camelops* cf. *C. hesternus*, continued.

Dimension	*C. hesternus* Hopkins, 1955 (UCMP 20040)	*C. huerfanensis* Hopkins, 1955 (I.S.C. 1500)	(USNM 7819)	(SMU 1.51)	*C. huerfanensis dallasi* Lull, 1921 (SMN 1.51)
$I\frac{3}{}$ mesiodistal diameter	17.8	21.5	20		21*
$I\frac{3}{}$ buccolingual diameter	9.7	16.5			
$C\frac{1}{}$ mesiodistal diameter	13.2	20.5			12*
$C\frac{1}{}$ buccolingual diameter		11.4			
Length diastema $I\frac{3}{} - C\frac{1}{}$		12R 14L	23	18R 16L	18R 16L

tentatively assigned to *Camelops* cf. *C. hesternus*. Although both teeth are smaller than might be expected for cheek-teeth of *Camelops*, they strongly resemble deciduous teeth Hay (1917, Pl. 1, Fig. 8; Pl. 2, Fig. 5 and 6) illustrated and assigned to *C. huerfanensis*.

The metapodials, though incomplete, are large and are indicative of *Camelops*. The recovered specimens represent distal portions, bearing deep, V-shaped, intermetapodial notches and long distal free ends. The distal free ends are moderately flared, indicative of genus *Camelops* (Breyer, 1974). Webb (1965, p. 24) pointed out that the length of metapodials and the cross-section of metapodial shafts of *Camelops* (? i.e. *C. hesternus*) are subject to great individual variation. The comparative measurements (Table 17) support assignment to *C. hesternus*.

Palaeoecological Implications

Camelops spp. (*C. hesternus* sensu lato) were widely distributed in North America during the Pleistocene. Specimens have been reported from Texas (*e.g.* Lull, 1921) to central Saskatchewan

Table 17. Measurements (mm) of metapodials of *Camelops* cf. *C. hesternus* from Riddell Site compared with measurements of metapodials of *Camelops hesternus* reported by Webb (1965, Table 10 and 12).

Dimension	*Camelops* cf. *C. hesternus*		*Camelops hesternus* (Webb, 1965)					
			Metacarpals			Metatarsals		
	VM3	VM5	N	$\bar{X}$	Min.-Max.	N	$\bar{X}$	Min.-Max.
Preserved length	135	120						
Length distal free ends	62e	55e	3	59.0	55 - 61	7	57.0	51 - 65
Mc III (Mt III) free end anteroposterior diameter	35.1e	36.2e	3	46.7	42 - 54	7	44.3	41 - 50
Mc III (Mt III) free end transverse diameter	35.5e	36e	3	45.7	43 - 50	7	44.3	43 - 45
Mc IV (Mt IV) free end anteroposterior diameter	36.5e	38.1e	3	45.0	42 - 49	7	44.7	42 - 56
Mc IV (Mt IV) free end transverse diameter	37.7e	36e	3	47.7	46 - 51	7	45.4	43 - 50

e = estimate, specimens are water worn so measurement is minimum

(Lammers, 1968). Camelids are also now known from deposits in Yukon Territory and assigned a Wisconsin age (Churcher and Wilson, 1979, p. 74). The present report confirms the northern extent of the distribution. In addition, there is evidence that camelids only recently (*i.e.* post-Wisconsin) became extinct in North America (Romer, 1929; Wilson and Churcher, 1978; Churcher and Wilson, 1979, p. 74).

Camelids apparently roamed North America in great herds during the Pleistocene and were restricted only by limitations of forage and water. They were primarily adapted for grazing but because of long neck and limbs were probably able to browse as well (Webb, 1965; Hager, 1975). The presence of *Camelops hesternus* suggests an open habitat and vegetative cover of grasses and broad-leafed trees.

FAMILY CERVIDAE

Cervidae indet., ?*Odocoileus*

Fig. 18

Geological Range

Pleistocene - Holocene.

Material

$LM^{\underline{1}}$ or $LM^{\underline{2}}$ (VM11); partial antler tine (VM430); ?partial scapula (VM354); ?left astragalus (tibial tarsal) (VM278); ?proximal [illegible]samoid (VM12).

Discussion

The upper molar is typically cervid; it is low crowned and bears persistent crescentic ridging. Only a faint distolingual cingulum is developed. The other specimens referred to this taxon are comparable in size and morphology to modern *Odocoileus*.

The criteria that separate genera of cervids are based primarily on antler characteristics as well as on some cranial and soft tissue characteristics. In general, teeth of *Rangifer* can be differentiated from those of *Odocoileus* on the basis of thicker enamel of the former, but the size variation of both genera tends to obscure these differences. The size of the tooth recovered from Riddell Site suggests that *Odocoileus* rather than *Rangifer* is represented. Assignment of the recovered specimens to *Odocoileus* is supported by Churcher's (personal communication, 1973) recovery of specimens of *Odocoileus* from sands exposed north of Sutherland on the east bank of the

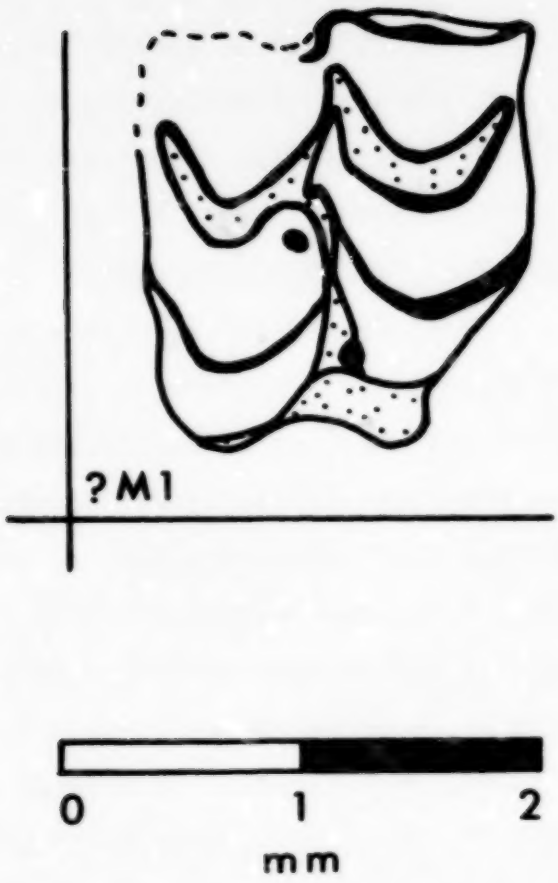

Fig. 18. Upper molar, LM$\frac{1}{-}$ of LM$\frac{2}{-}$ of *?Odocoileus* from Riddell Site (VM11, occlusal aspect).

South Saskatchewan River.

Odocoileus hemionus and *O. virginianus* are both recent inhabitants of the Canadian prairies, occurring sympatrically, the former being limited in its eastern extent. *Rangifer* currently occupies the area to the north of *Odocoileus*, into the Arctic and into high mountains such as the Cariboo Mountains. On the evidence available from Riddell Site any one of these three forms could be represented.

Odocoileus has existed in North America since Pliocene and *Cervus* since early Nebraskan time; *Rangifer* has been recorded from the Wisconsin and Holocene (Hibbard *et al.*, 1965, Table 2; Hibbard, 1970, Appendix). However, Russell and Churcher (1972, p. 19 - 20) identify *Rangifer* sp. from the Yarmouth fauna and *R. tarandus* and *Rangifer* sp. from the Sangamon fauna of Medicine Hat, Alberta, where they were sympatric with *Odocoileus* and *Cervus*.

Palaeoecological Implications

Modern *Odocoileus* and *Rangifer* are allopatric and occupy separate niches; the latter is the more northern and arctic form preferring forest and tundra environments while *Odocoileus* prefers the

more open habitat afforded by aspen parkland and open prairie. However, both genera are known from deposits of assigned Sangamon age in Medicine Hat, Alberta (Russell and Churcher, 1972, p. 19 - 20). This suggests that modern allopatry of species of cervids is a recent phenomenon and cannot be used reliably to indicate past environments.

Deer are a common element in the extant fauna of the Saskatoon area. They are readily adaptable as is evident from their successful coexistence with man.

FAMILY ANTILOCAPRIDAE

Antilocapra cf. *A. americana* (Ord), 1815

Fig. 19

Geological Range

Rancholabrean - Recent (Late Pleistocene - Holocene).

Material

Left humerus, damaged and restored (VM6); left astragalus (tibial tarsal) (VM7); right os innominatum, partial (VM8); middle phalanx, juvenile (VM9); epiphysis of distal free end of metapodial (VM10).

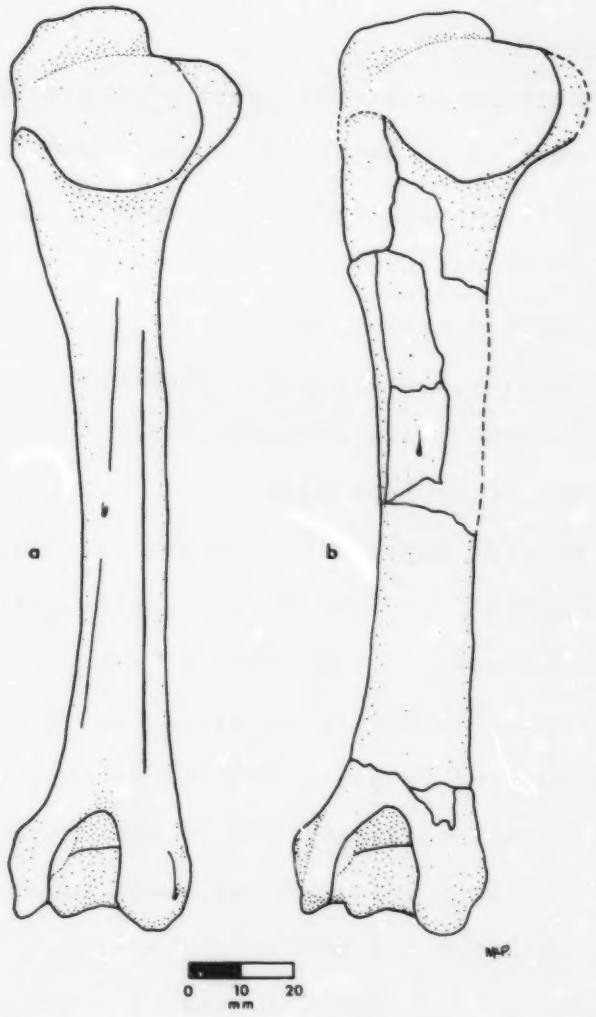

Fig. 19. Comparison of left humerus of extant *Antilocapra americana* (a, U. of S. Biology 2353, posterior aspect) and of *Antilocapra* cf. *A. americana* from Riddell Site (b, VM6, posterior aspect).

Discussion

The five recovered specimens have been questionably referred to *Antilocapra americana* on the basis of comparison with modern specimens. In general these specimens are indistinguishable from their modern counterparts. The specific diagnostic characteristics are cranial elements, especially the horn cores, and without these a definite specific assignment cannot be made.

The left humerus was broken when recovered; the minor (medial) tuberosity and approximately half the caudal wall of the shaft of the bone is missing (Fig. 19, Table 18). The pelvis is in fragmented condition; the largest restored portion consists of the acetabulum and portions of the ilium and pubis. The other three referred specimens were recovered intact although the middle phalanx (VM9) and the epiphysis of a distal free end of a metapodial (VM10) indicate juvenile individuals and are proportionately small.

Several differences between the specimens from Riddell Site and modern specimens with which they were compared have been observed but these are not

Table 18. Measurements (mm) of the humerus of *Antilocapra* cf. *A. americana* from Riddell Site compared with measurements of humeri of modern *Antilocapra americana* taken by the author and from Colbert and Chaffee (1939); of *Tetrameryx onusrosagris* taken from Colbert and Chaffee (1939); of *T. shuleri* from Dalquest (1967); and of *T. conklingi* from Stock (1930).

Dimension	*Antilocapra* cf. *A. americana*, VM6	*Antilocapra americana* (U. of S. Biology 2353)	*Antilocapra americana* (Colbert and Chaffee, 1939)	*Tetrameryx onusrosagris* (Colbert and Chaffee, 1939)	*Tetrameryx shuleri* (Dalquest, 1967, #5173)	*Tetrameryx ?conklingi* (Stock, 1930, #179)
Maximum length	190e	192	178	186.5	189.0	147.5
Anteroposterior diameter across proximal articular surface	63e	56				42
Transverse diameter across proximal articular surface	45e	46				32.2
Transverse diameter across distal articular surface	38	36			37.3	30

e = estimate

considered critical. The canal allowing communication from the base of the acetabulum to the obturator foramen of the pelvis has a small diameter in the fossil specimen (2-3 mm) while it has a large diameter in modern specimens examined (10 mm). Modern specimens have roughened areas (rugosities) and prominences lateral and medial to the ilial portion of the acetabulum for the attachment of rectus femoris muscles; in the referred specimen the medial area of attachment has been formed into a pronounced bean-shaped depression.

The astragalus is larger than astragali of modern *Antilocapra americana* to which it was compared, and lacks the functional stop at the base of the lateral ridge of the proximal trochlea, the absence of which could be due to post-mortem wear. The size difference could be significant at the generic level as several Pleistocene genera are said to differ in size as well as in horn configuration (see Taylor, 1911; Skinner, 1942). Table 19 provides comparative measurements of astragali.

Several genera of Pleistocene antilocaprids have been described: *Breameryx* (Furlong, 1946b),

Table 19. Measurements (mm) of the astragalus of *Antilocapra* cf. *A. americana* from Riddell Site compared with measurements of astragali of modern *Antilocapra americana*; of modern *A. americana* and early Pleistocene ?*Tetrameryx* sp. taken by Churcher (personal communication, 1978); of *Capromeryx furcifer* taken from Hibbard and Taylor (1960); and of *Tetrameryx conklingi* taken from Stock (1932).

Dimension	*Antilocapra* cf. *A. americana*, VM7	*Antilocapra americana* (U. of S. Biology 2353)	?*Tetrameryx* sp. (Churcher, pers. comm., NMC 17754)	*Antilocapra americana* (Churcher, pers. comm., ROM 37325)	*Capromeryx furcifer* (Hibbard and Taylor, 1960, KU 7428)	*Tetrameryx conklingi* (Stock, 1932)
Greatest length on lateral surface	37.3	34.2	39.8	37.7		28.9-32.8
Greatest length on medial surface	34.1	31.7	35.8	34.3	22.0	
Minimal length	29.1	26.9				
Distal width	23.6	21.3	24.3	23.3	14.0	18.5-19.7
Greatest depth on medial surface	21e	20.8	22.4	21.2		

e = estimate

Capromeryx (Matthew, 1902; Taylor, 1911), *Stockoceros* (Frick, 1937; Furlong, 1946a), and *Tetrameryx* (Lull, 1921; Colbert and Chaffee, 1939). *Antilocapra americana* is also known from Pleistocene deposits (Schultz, 1938). The primary diagnostic characters are those of the horn-cores; overall body size is also an important feature distinguishing, for example, *Capromeryx* from the other genera (see Taylor, 1911; Skinner, 1942).

Lull (1921), in his original description of *Tetrameryx shuleri*, stated that this form closely resembles *Antilocapra americana* in size and dental characteristics. The major difference is the presence of four rather than two horns in the former. The post-cranial material described by Colbert and Chaffee (1939, p. 8 - 15) indicates that *T. onusrosagris* (Roosevelt and Burden, 1934) approximates the size of *A. americana* but is slightly more robust and more heavy set. This is evident in the relative proportions of the upper and lower limb elements (Colbert and Chaffee, 1939, p. 17).

The identification of the antilocaprid specimens cannot be made with certainty even to the generic

level. The available evidence indicates that an antilocaprid is represented in the fauna. The size of the recovered elements suggests that an animal the size of *Tetrameryx onusrosagris*, *T. shuleri*, or *Antilocapra americana* is represented. The specimens compare favourably with specimens of modern *A. americana* but the minor differences discussed above and the absence of key elements makes definite assignment to *A. americana* impossible. It may well be that future recovery of diagnostic elements will suggest assignment to *Tetrameryx*.

Tetrameryx is known from deposits of assigned mid-Kansan to late Wisconsin age (Hibbard *et al.*, 1965, Table 2). An incisor and an astragalus from an antilocaprid are recorded from early Irvingtonian (Aftonian) deposits in southwestern Saskatchewan. They were originally recorded as *?Antilocapra* (Russell and Churcher, 1972) but were subsequently assigned to *?Tetrameryx* (Churcher, personal communication, 1979). Russell and Churcher (1972) also list an indeterminate antilocaprid from deposits they date as Kansan, and *?Antilocapra* cf. *americana* from Sangamon and Wisconsin deposits at Medicine Hat,

Alberta. Hibbard *et al.* (1965, p. 513) and Hibbard (1970, Table 8) considered *Antilocapra americana* a Wisconsin and Recent species.

Palaeoecological Implications

Pronghorn inhabit plains, steppes, deserts, and foothills seeking protection in coulees and river valleys. They do not occur on damp or wooded land. In prehistoric time the range of *Antilocapra americana* extended over most of the treeless prairie and at least as far north in Saskatchewan as the confluence of the North and South Saskatchewan Rivers. The major food source for modern antelope is forbs; woody browse and grasses are a minor constituent (see Banfield, 1974, p. 403 - 404). In Saskatchewan, however, woody evergreen browse is the major winter food.

In recent years the distribution of *Antilocapra americana* has been severely limited by human interference over its range. Thus, interpretation of habitat preferences of fossil antilocaprids, even fossil *A. americana*, is very difficult. Post-glacial climatic and faunal zonation, too, may have dramatically affected modern antilocaprid distribution.

CONCLUSIONS

Nineteen taxa of mammals are represented in the Riddell local fauna of which only three (Proboscidea indet., *Equus conversidens*, and *Camelops hesternus*) are extinct. Four taxa (*Lepus* sp., *Microtus* sp., Proboscidea indet., and *Odocoileus*), are known from pre-Pleistocene time and *Equus conversidens* is known throughout the Pleistocene. The remainder are limited to Pleistocene and Recent time (Fig. 20).

Lagurus curtatus and *Ondatra zibethicus* restrict the age of the Riddell local fauna to late Rancholabrean. I follow Repenning (personal communication, 1979) and use the presence of *Lagurus curtatus* in North American faunas to mark the beginning of late Rancholabrean time (the Pleistocene succession in North America is illustrated in Fig. 4). *Ondatra zibethicus* is poorly represented in the Riddell local fauna but there is sufficient evidence to confirm that the muskrat in the fauna had reached the *O. zibethicus* grade of evolution and is indicative of late Rancholabrean time.

Clethrionomys is believed to have been introduced into North America by a holarctic arvicoline

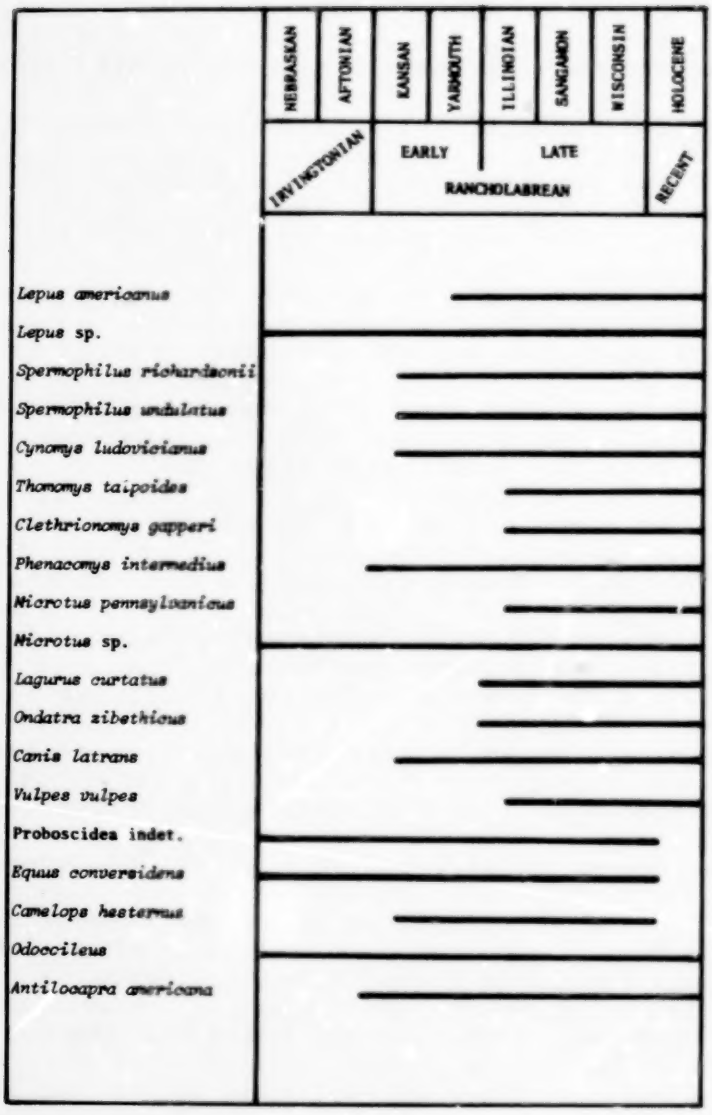

Fig. 20. Temporal distribution of the mammals of the Riddell local fauna.

dispersal event dated at about 600 000 years B.P. which dates the beginning of Rancholabrean time in North America (Repenning, 1978, p. 51). The first reports of *C. gapperi* are from deposits of reported Illinoian age suggesting that dispersal of this taxon may have taken place along with that of *Lagurus curtatus*.

Genus *Thomomys* is known from early Pleistocene time but the first reports of *T. talpoides* are of assigned Illinoian age. This suggests that the modern grade of evolution may not have been reached until late Rancholabrean time.

The palaeoecological implicatons of the Riddell local fauna, based on the habitat preference and modern ranges of the extant taxa, suggest an equable climate. Sympatry of arvicoline rodents (e.g. *Microtus* spp., *Clethrionomys gapperi, Lagurus curtatus*) and the presence of *Cynomys* cf. *C. ludovicianus* suggest that temperatures may well have been less extreme than they are today. The taxa represented in the Riddell local fauna indicate that the landscape was dominated by open grassland with trees and shrubs occurring in low areas and

along river valleys.

The evolutionary grade and known geological range of the taxa represented in the Riddell local fauna suggest a late Rancholabrean age for the fauna. The ecological diversity represented does not support the young late Wisconsin age suggested by the radiometric date of 15 340±500 years B.P.

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